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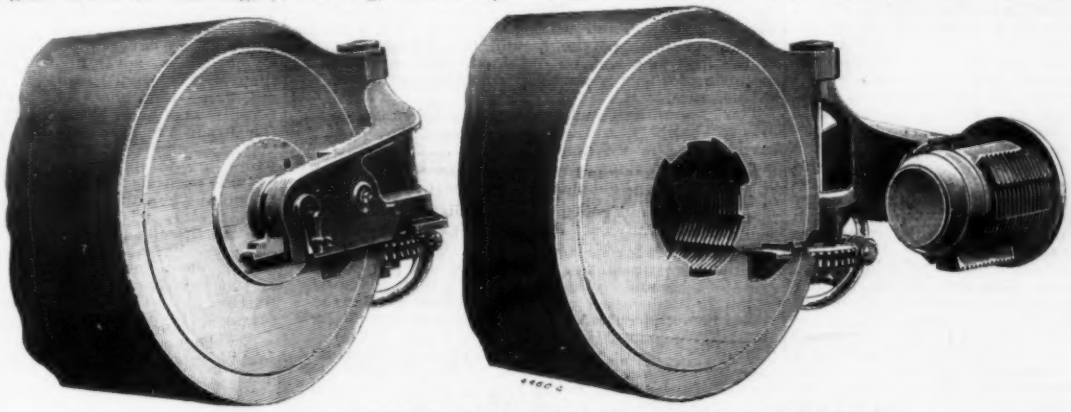
VICKERS' GUNS.

MESSRS. VICKERS, SONS & MAXIM, Limited, manufacture every type of ordnance, their plant being capable of dealing with guns of over 100 tons weight, but the demands of the artillerist are now confined within the limits marked by the 50-ton gun, hurling an 850-pound projectile from the muzzle with a velocity of 2,750 feet per second, and the automatic gun firing as many as 800 shots per minute. The large breech-loaders for use in battleships include 12-inch, 10-inch and 9·2-inch caliber guns, while the quick-firers are 8-inch, 6-inch, 4·7-inch, 4-inch and 3-inch weapons, with many Maxim and machine guns. The method of constructing most of the larger guns is known generally as the steel and wire-wound system.

An interesting feature of all the guns is the breech plug, originally invented by a Swedish engineer (Mr. Axel Welin). It is made in segmental portions in steps of varying radii, as will be readily seen from Fig. 2. By this arrangement a plug divided, say, into eight segments would have six segments, or three-quarters of its circumference, threaded for meeting the strains on the breech; while the ordinary parallel breech plug, with thread and plane surface alternating, has only half its circumference threaded, the other half being useless for resisting the back pressure in firing. This enables the plug to be shortened by one-third of its length, and proportionately lessens the weight. The reduction is of great importance, as the gun is shortened at its heaviest part, which means considerable reduction in its weight. The breech plug, too, can be more easily swung clear of the breech after unlocking, without any curvature, and without the usual longitudinal withdrawal. This can even be done with the De Bange obturator.



FIGS. 4 AND 5.—BREECH MECHANISM OF VICKERS' 12-INCH GUN.

The breech mechanism for the 12-inch, 10-inch and 9·2-inch guns is fitted with the necessary gear to enable it to be worked by hydraulic or other power; it is applicable to any gun of smaller or larger caliber, and is suitable for either a right or left-hand gun. The mechanism is so arranged that by turning the hand wheel the breech plug is first rotated and unlocked, then drawn longitudinally to the rear until the obturating pad is clear of its seat and finally swung out of the breech of the gun. The horizontal sliding bar mounted in the carrier has one end connected by a roller stud to the arm which is fixed to the hinge bolt of the carrier. On the top of the sliding bar are formed teeth into which is geared a pinion, pivoted in the recess in the carrier. This pinion is keyed to the shaft on which is fixed the actuating lever. Projecting from the actuating lever is the roller stud which works in a slot in the rear face of the breech plug to rotate it. On the stem of the carrier, on which the breech plug is carried, there is fitted, with freedom to turn, the sleeve with a forked arm projecting from it. On the outer circumference of the sleeve are three inclined grooves of increasing pitch. Three roller studs, mounted on a ring fitted into the bore of the breech plug, work in the inclined grooves of the sleeve in such a manner that a longitudinal movement is given to the breech plug, when the sleeve is turned by a roller stud, which projects inwardly from the face of the horizontal sliding bar, and works in the forked arm of the sleeve. A worm and worm wheel operated by a hand wheel are carried in a suitable position at the breech of the gun, and when rotated, cause the movement of the actuating arm.

To open the breech the hand wheel is rotated, and thus, by means of the worm wheel, the actuating arm is moved, causing the sliding bar to move horizontally. This revolves the pinion and the actuating lever, which in turn rotates the breech plug, at first slowly, and then more rapidly, until it becomes unlocked. The sleeve, which is held in position until the plug becomes unlocked, by means of a projecting pin working in a

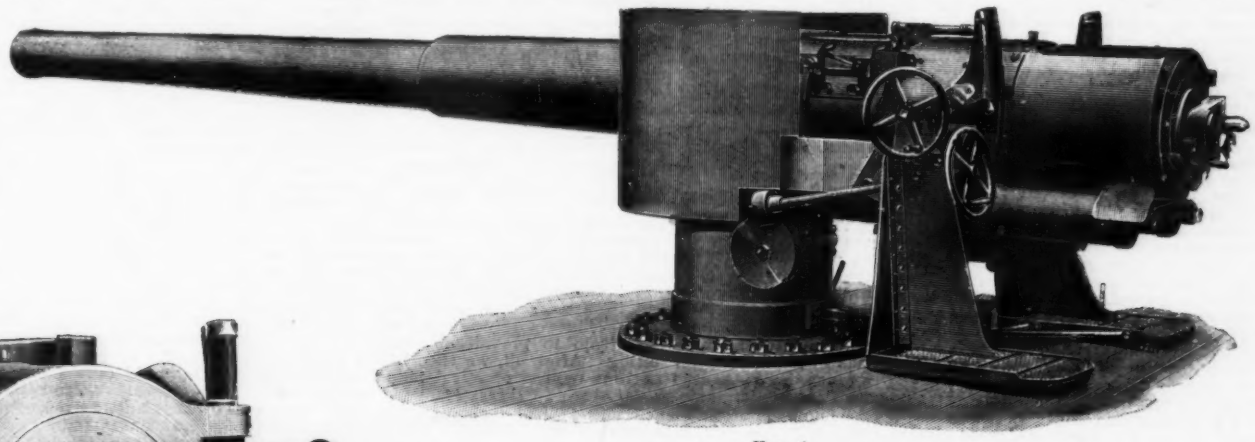


FIG. 1.

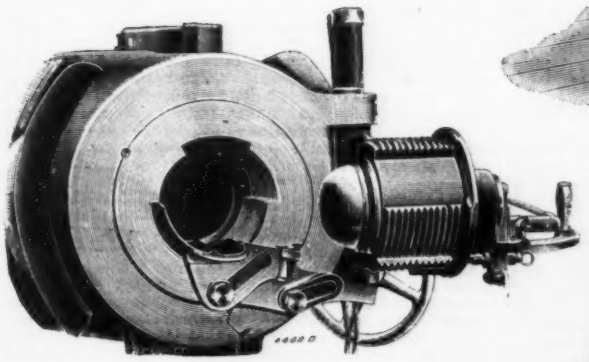


FIG. 2.

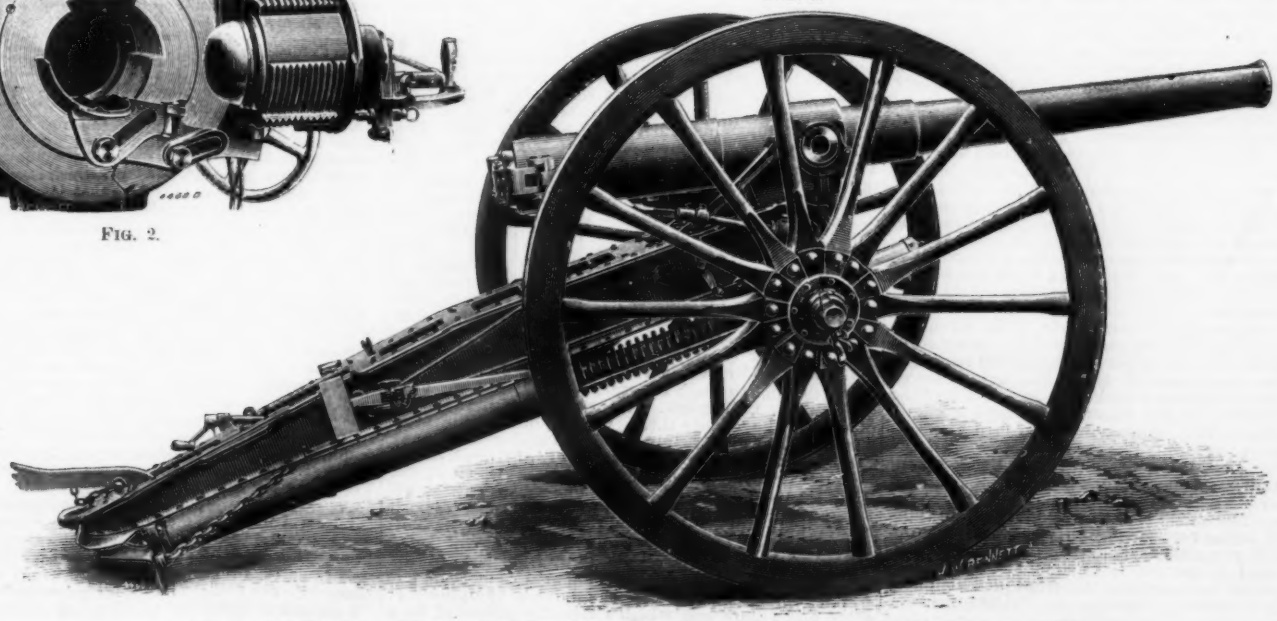


FIG. 3.—VICKERS' 6-INCH QUICK-FIRING NAVAL GUN AND 3-INCH FIELD GUN.

groove in the face of the sliding bar, is now free to turn, and by continuing to move the sliding bar the projecting roller stud engages the forked arm of the sleeve and so turns it. The rotation of the sleeve causes the plug to move longitudinally rearward by means of the projecting studs working in the inclined grooves of the sleeve. After the plug is drawn longitudinally rearward, the continued movement of the actuating arm swings the mechanism out of the breech of the gun.

The gun is arranged for firing by electric or percussion tubes, and its action is similar to that of our 6-inch quick-firing gun. Provision is made so that the mechanism can be worked by hydraulic gear. Suitable clutches are provided, so that the change from hand to hydraulic gear, or vice versa, can be easily and rapidly effected by the rotation of a small hand wheel.

With a charge of 207 pounds of cordite, and using 850 pound shot, a muzzle velocity of 2,750 feet per second and a muzzle energy of 44,573 foot-tons can be obtained with this very serviceable 12-inch 50-ton gun, for which Messrs. Vickers, Sons & Maxim, Limited, have an admirable type of mounting for use within barbettes, whereby the gun can be rapidly worked in action, giving considerable rapidity of fire, without introducing any delicate or complicated mechanism.

The 8-inch and 6-inch quick-firing obturating gun of 45 calibers, the latter of which is illustrated in Figs. 1 and 2, are equally remarkable in respect of the simplicity of their mechanism and the high energy developed. The guns are of steel and wire construction; and the total length from the breech face to the muzzle is 31 feet in the case of the 8-inch, 23 feet 3 inches in the 6-inch weapon. The 8-inch gun with a charge of 52 pounds of cordite, and using 210-pound projectile, attains a muzzle velocity of 2,750 feet per second and a muzzle energy of 11,012 foot-tons. With 25 pounds of cordite for a charge, and using 100-pound shot, a muzzle velocity of 2,775 feet per second and a muzzle energy of 5,340 foot-tons has been obtained with the 6-inch gun. The breech mechanism is also illustrated, the view showing the breech open.

The breech plug is opened or closed by the horizontal movement of a hand lever. The same action rotates, locks or unlocks the plug, swings it in or out of the gun around the pivot on which it is mounted, and causes the percussion and electric striker to make or break contact at the required positions during the working of the mechanism. The arrangement consists of a link, one end of which is so pivoted on a pin projecting from the rear face of the breech plug that the link works in a plane parallel to the breech face of the gun; while the other end is pivoted to a short crank mounted on the plug carrier, and around the boss of this crank are formed "skew gear" teeth. The hand lever for actuating the breech mechanism is pivoted on the plug carrier, and moves in a plane at right angles to the breech face of the gun. Around the boss of the hand lever is fitted a skew gear wheel, which gears with the skew teeth formed on the boss of the crank.

The whole is arranged and proportioned in such a manner that when the breech is closed, the hand lever lies close up to the breech face of the gun. The arrangement of centers and pivots, together with the relative lengths of the link and crank, provides great power when opening or closing the breech.

On swinging the hand lever away from the gun, so as to open the breech, the crank moves the link past the locking center a short distance, without causing any perceptible movement of the plug. The further movement of the hand lever causes the crank to turn, and by means of the link rotates the plug, at first very slowly (thus obtaining great power), and then more rapidly, until it becomes unscrewed. The carrier then moves with the lever, swinging the plug clear of the gun.

A loading tray is provided, which is automatically moved across the breech face and raised into the loading position when the breech is being opened, and lowered when it is closing. The firing gear is arranged for firing by electric or percussion tubes, and is operated by the movement of the hand lever and link. It is so arranged that the first movement of the hand lever, when unlocking the breech, acts on the firing gear and makes the gun absolutely safe before the breech plug commences to unscrew. By the continued movement of the link the empty tube or primer is automatically ejected. The form of breech mechanism described, which is a patent of the company, embodies several marked improvements over existing designs. There is a considerable reduction in number of parts. The mechanism is quickly and easily taken to pieces, while the accessibility of the parts is a great feature. The lever which opens and closes the breech by a horizontal movement occupies a very small horizontal area, so that the mechanism is easily worked in a restricted space. An improved and strengthened form of loading tray has been introduced, whereby existing difficulties as regards the tilting of the shot are entirely overcome.

The casemate mounting for these two quick-firing guns only differs in slight details. It consists of a steel top carriage resting on balls running on ball bearings on a steel pivot. The cradle in which the gun slides is a cylinder; attached to the cradle are three cylinders, one to overcome the recoil and the other two (one on each side of the recoil cylinder) contain the springs for running the gun up to the firing position after the recoil. The connection between these three cylinders of the gun is made by arms projecting from the breech ring. The whole weight of the moving parts, gun, cradle and carriage, is taken on the balls above referred to, so that the training is very easy. The elevating and training operations are performed by the rotation of two hand wheels conveniently placed with regard to the shoulder piece against which the gunner leans. These two hand wheels are worked on the left side of the mounting, which has also an auxiliary hand wheel on the right side, so that, if necessary, two men can conveniently train the gun. The recoil cylinder is of the usual construction, being fitted with a valve key supported at both ends, the valve key being of stronger section than is usual, and the whole arrangement of fewer parts. The shield is of the usual casemate type, the pedestal being very strong, to withstand the impact of small projectiles. This type of mounting affords increased protection from shell fire by the construction of the top carriage, the front of which is of considerable thickness, while the general arrangement of the several parts, such as recoil cylinder, spring cases elevating and training gear, is well disposed and under exceptional protection. The parts are few in number, easily kept in good repair, very little attention being necessary. The form of cradle is of strong design and completely covers in the breech end of the gun, thus preventing dirt, grit, etc., impairing the working.

The 4·7-inch quick-firing gun is also of 45 calibers, the total length from the breech face to the muzzle being 18 feet 1 inch, and with 9 pounds of cordite for a charge, and using 45-pound shot, a muzzle velocity of 2,600 feet per second and a muzzle energy of 2,109 foot-tons can be obtained. The breech mechanism is similar to that described for the 6-inch quick-firing gun (obturating). Sometimes a metallic case is used in place of a "De Bange" obturator, the firing and safety gear being modified to suit, and no shot tray is required.

The mounting is somewhat similar to the 6-inch quick-firing gun just described, but with this slight difference, that while the cradle in which the gun slides has a similar cylinder to overcome the recoil, there is only one cylinder for running the gun forward after recoil.

Another noteworthy weapon is the 12-pounder (3-inch) quick-firing naval gun, a favorite weapon among the auxiliary armament on all warships. The breech plug and mechanism is similar to that described for the 6-inch quick-firing gun. With 2 pounds 9 ounces of cordite for a charge, and using 12·5-pound shot, a muzzle velocity of 2,700 feet per second and a muzzle energy of 632 foot-tons can be obtained. The center pivot mounting for this 12-pounder is similar to that of the 4·7-inch gun.

The 12-pounder 3-inch, quick-firing field gun (see Fig. 3) is 23·5 calibers, and the characteristic feature of the carriage is the method of taking up the recoil. All parts of the carriage are free to recoil except the hydraulic buffer, which is placed between the side cheeks of the trail. The front end of the buffer piston is attached to the front end of the carriage, and a strong spade is fixed to the rear end of the hydraulic cylinder. The cylinder is further connected to the trail by chains. Around the part of the piston rod which projects outside the hydraulic cylinder is placed a powerful spring, which is compressed at the same time as the rod is forced into the cylinder. The trail is of special form and length, so as to slide freely back and obviate all "jump." On firing, the spade is forced into the ground, thereby arresting all movement of the cylinder rearward, but the trail, being free to move to the rear, forces the hydraulic cylinder and springs to assist in taking up the recoil, while the spring serves to run the gun forward into position again.

The gun is connected by trunnions to the top carriage, which is pivoted to the front part of the trail, so that it can be trained through an arc of 8° (i. e., 4° on either side of the axis of the mounting). This permits small adjustments in laying without any movement of the trail. If required, the hydraulic buffer can be removed in about one minute; the mounting may then be used as an ordinary field carriage, and the recoil, which will then be about 7 feet, is checked by means of ordinary shoe brakes applied to the tires of the wheels. A rate of fire of 12 aimed rounds per minute may be obtained with the use of this mounting. This system affords an efficient method of absorbing the energy of recoil and returning the gun to the firing position without disturbing the laying, and without subjecting the mounting to any excessive strain, combines the advantages of a quick-firing gun with the lightest possible construction of mounting, which is due to the length of recoil and to the mass of the recoil parts.

We are indebted to London Engineering for the interesting engravings and text.

THREE-COLOR PHOTOGRAPHIC PRINTING.

By Capt. W. DE W. ABNEY, C.B., D.C.L., F.R.S.

THE Society of Arts has done me the honor to ask me to read a paper on three-color printing by means of photography. I have responded affirmatively to the request for the reason that I am most obviously unbiased by any external influences of trade secrets, and that I can approach it from a scientific side, and that I have no practical knowledge of any systems of trial and error, which are said to prevail in some classes of three-color printing. After all, we theorists are not to be despised entirely by the practical man, for I need only allude to Mr. Ives to show you what predominant an influence science has had on some who felt the evil influence of rule-of-thumb work. When we have to deal with colors we have invariably, for theoretical purposes, to resort to—I nearly said sall back upon—the spectrum for inspiration as to how to proceed; and to-night I shall attempt to explain to you the theoretical basis on which three-color printing ought to be worked. We have the spectrum on the screen, and we see that at first sight and without detailed examination it appears to be made up of red, green and blue, which includes the violet. The other colors may be called incidental. It is this red, green and blue which, when mixed together in varying proportions, give us any or all of the colors of nature. The colors are now recombined by means of a lens to form a white patch, and if we pass a slit through the spectrum, we get practically patches of monochromatic light on the screen. Passing a series of slits through the spectrum without interposing a lens, we get overlapping images of the face of the prism we are employing for analyzing the electric light, and the overlaps show us that red and green make yellow, and blue and green that greenish blue which is often called peacock green or blue, while blue and yellow make white. Replacing the lens, it combines all the colors passing through the various slits, and we have a patch of mixed colors. If, instead of a multiplicity of slits, we have only three, we can obtain the same effects. We can multiply our colors and tones to any extent by opening more or less widely any or all of the slits. Instead, however, of altering the width of the slits, we may obtain the same effects by cutting off more or less light by means of photographic deposit on developed plates placed in front of the slits. This we do, and we see that we get colors of varying hues. Or we can cut off more or less light from the slits by rapidly passing in front of them apertures more or less widely apart. In fact, we can have a symphony of color, and I show one which I recently prepared for a lecture at the Royal Institution. We can have various harmonies as it were by means of this arrangement. But I also wish to show that in order to produce these colors it is not essential to have any very pure colors, for I can withdraw the slits and let those parts of the spectrum which are opposite the three lines of apertures (holes) pass through, and they will combine, and we have still practically the same symphony of color on the screen. We thus see that we may use a considerable part of the spectrum at three places and still obtain good effects of color. Now, Mr. Ives has already in this theater shown how he combines the light coming through colored media to obtain his beautiful results, and I can here show you that by the use of media like his any color of the spectrum can be obtained. By use of three glasses in a disk, and by cutting out suitable masks and then sending a slice of light through them while they are rotating, we have a very fair representation of the spectrum.

Thus every color of the spectrum with a fair amount of accuracy may be represented by the mixture of the light coming through these three glasses, if the intensities are properly arranged. So far, then, we have seen that by mechanical means we can obtain any shade or hue of color. It now rests with us to see how we can utilize this scientific fact to produce the colors as seen in nature by means of photography. Taking the spectrum colors, we find that certain width of slits in the three colors—red, green and blue—give white. If we cover up the blue slit we find that we have a yellow, if we cover up the green it is purple, and if the red, it is a blue-green. If, then, we have media of red, green and blue, which allow the same relative brightness of these three colors to pass through as do the slits in the spectrum, we readily see how a red, a yellow, a green, a blue-green, and blue, as well as white, are to be secured by means of three photographic positives. Suppose the problem before us as to how we should represent flat surfaces of these seven colors which have the same relative brightness as these spectrum colors on paper, how should we proceed? If we photograph them on three different plates, and take transparencies from them; and manage that the colors on each transparency are represented as follows (total transparency being represented by T and perfect opacity by O)

	No. 1 Plate.	No. 2.	No. 3.
White	T	T	T
Red	T	O	O
Purple	T	O	T
Yellow	T	T	O
Green	O	T	O
Blue-green	O	T	T
Blue	O	O	T

we shall find that if No. 1 be backed by a red medium, No. 2 by a green medium, and No. 3 by a blue, each of the right brilliancy to make a white when mixed, then the images when superposed would give the seven colors exactly. Again, suppose we had a dull yellow of half the intensity of the spectrum yellow—if in No. 1 and No. 2 plates the transparency were in each reduced to half (say)—then we should get the reduced yellow, and so on. We can form some idea of the way the three images when backed should look by an artifice that I have introduced for producing a monochromatic image. We can throw an image of the carbon points on the prism, and the light after decomposition by the prism, and recombination by the lens outside the spectrum, will form an image of the surface of the prism upon the screen, and as this surface has an image of the carbon points upon it, the carbon points are seen on the screen. We may place three slits in the spectrum, and again we have the same (mainly) white image. By using three lenses instead of one, we can project each colored image separately and have them side by side. Instead of the carbon points, we can place against the prism small squares of colored glasses and we get the three images of these. The one corresponds to the transparency to be illuminated by the red, the next by the green, and the third by the blue. It is such transparencies that we must aim at obtaining. Now I need scarcely say that a negative taken through a red medium, and second through a pure green medium, and the third through a pure blue medium would not be effective. Think of what a spectrum on the screen would look like if thus photographed. One negative would give a transparency which would only allow a narrow band of red to show, the next of green and the next of blue, and thus the spectrum would be represented by three bands of color simply. There would be no overlapping of colors to show the intermediate colors. It is evident that we must obtain media which would allow more of the spectrum to pass through in order to obtain an overlap.

Quite recently, at the Camera Club, I have brought forward a color sensitometer to enable a plate to be tried for the three colors most suitable to use as taking screens. The principle on which this is designed is as follows: Take a number of small colored squares of glass such as enumerated above, which only allow certain colors to pass through. Choose the three colors with which the three transparencies are to be backed, and by mixture of these standard colors find out how much of each of them is required to match the colors of the glasses both in intensity and hue. Measure the brightness of the light coming through the colored glasses. Then to make a sensitometer to enable you to choose the proper screen for taking the "red negative," as I will call it, reduce the brightness of the different glasses to the extent which is necessary to cause all the red light required to come through the different colors to be of equal intensity. Then in a proper negative all of the deposits should be of equal opacity, and for any brand of plate used a screen must be sought for which will give this result. Take another similar set of glasses and reduce the transmission of them so that the green transparency should allow equal light to penetrate, and a screen must be sought for till such is the case. The same for the blue. We thus shall have found three screens through which to photograph to give us three transparencies from the three negatives that when backed with the chosen colors, red, green and blue, will give us the true colors of the objects. This sensitometer, I hope, may prove of use in the future to those who are doing three-color printing.

I am not to have the privilege of showing you Mr.

Ives' work to-night, so far as three combined images are concerned, because he has shown you them himself on a previous occasion; but I am allowed to show you what is a modification of it, viz., Joly's process. Dr. Joly obtains only one negative, but that negative really contains three. In contact with the plate he places a screen ruled in three colors with lines $\frac{1}{100}$ of an inch broad, and touching one another. One line answers to the red-taking screen, another to the green, and the third to the blue. (In front of the lens he places a colored medium to tone down the blue.) The plate is exposed through this screen, and as a result he obtains the red, the green and the blue negative intermingled one with another, each being represented by one-third of the surface. From this a transparency is made, which is backed by another ruled surface of red, green and blue lines of the same width, and proper intensities. The red lines fall on the portions which were taken through the "red-taking" lines, the green on the green and the blue on the blue, so that we have a colored representation of the objects, and very beautiful they are. We can show you a taking screen, a viewing screen, a negative, a positive, and a positive backed by the ruled screen, and that will give you the process. (Slides were here shown of various colored objects.)

We have now led up to the question of photographic printing in color, not by mixing the light coming through three separate transparencies, but by the use of transparent colors and using the negatives from which to obtain colored images. This is really a question of absorption of light, and depends on exactly the same principles as have been just enunciated for the mixture of light from three images. We may take it that the colors suitable to back the positives must form the basis of any process; but we shall see that the colors to be used are exactly complementary colors to the three fundamental monochromatic colors of red, green and blue. A complementary color is that color which with the original will give a white.

Reverting to the spectrum, we place the three slits in it and once more form white light. The red and the green and the blue are now in proper proportions. If we cover the red slit up, we have a blue green formed, and that is the color with which we must print from the red negative. When the green slit is covered up we have a pink or purple, and that is the color to be used with the green negative; and a bright yellow similarly is derived from covering up the blue slit, and is the color that must be used with the blue negative.

These, be it remembered, are exactly the complementary colors of the fundamentals, and the nearer we can imitate these, the more correct we shall be. If we pass an opaque strip along the spectrum, we shall see we have the complementary of the color blocked out; but in this case, if the strip be very narrow, the complementary will be too white. The criterion as to the suitability of the colors in regard to purity is that, when two colors are superposed, the resulting color should approximately equal in hue and purity the fundamental color. Here I have, thanks to Mr. Warnerke, several graduated annuluses of gelatine colored with pink, blue-green and yellow. I place them in the spectrum, and we see that we have a fairly large portion of the spectrum transmitted through all, though in different positions and overlapping. (The transmission of a small band of red through the blue-green is a misfortune, though it counts but little in reality.) Placing the pink and blue-green together and sending the light through them both, we see that we have a fair blue. With the pink and the yellow together we have a good red, and with the yellow and the blue-green together we have a good green. These colors match very fairly Mr. Ives' standard colors, which should not be widely departed from for practical purposes. We may take it, then, that these particular hues that I have shown are not far off theoretical correctness.

Now why have we to print the red, green and blue negatives with these complementary colors to obtain a print in color?

Let us take the instance of a white object. Here each of the three negatives would show the white as opaque deposit; consequently, when printing each of them on some sensitive surface colored with these complementary colors, there would be a blank on each, and if the three images were superposed on white paper, there would be no coloring matter from any of them. Let us take a red object. Here the red negative would show the object as opaque, while the green and blue negatives would show it as totally transparent. If the green negative be printed on a sensitive surface and colored with pink, we should have for the red object a full pink, and if the blue negative were printed with a yellow, we should have it a full yellow.

When the two transparent but colored films are superposed, we should have a yellow film lying over a pink film, and, as we have already seen, the light penetrating would be a red.

Once more, let us take a bright yellow. Here our table shows us that we shall have total opacity in the red and green negatives (since in the transparencies they have to be shown as totally transparent). Consequently, the only negative which when printed on the appropriate sensitive surface is the blue, and that we have to print in yellow. Hence we have the object shown in yellow on the white surface. Mr. Ives has shown this fact in making lantern slides by this method. He prints on bichromated gelatine, and then dyes his three prints with the appropriate complementary colors and superposes them.

Of this method he has kindly lent me a few specimens. What answers for the lantern slide will also answer if the films are placed on paper. This would be photographic printing; but the same principle applies to blocks. Suppose a typo block is prepared from the red, green and blue negatives by any of the various processes, and that the block from the red negative is worked in with transparent blue-green ink, that from the green negative with transparent pink ink, and that from the blue with transparent yellow ink, and that these separate impressions are superposed with accurate register.

Then we have a mechanical method of printing in colors. This is the theory of the matter, and all practice must eventually be derived or come to it. There are several firms who work in these directions, and no more beautiful work has been done than by Messrs. Waterlow, who have kindly allowed me to show some specimens of their work. The Graphic send specimens of their three-color printing, and also Messrs. Cassells, and excellent work it is.

Mr. Warnerke informs me that in Russia a machine has been perfected which allows the three inks to be distributed uniformly over each block, and that each block prints on to a hard surface, the registration being made in the most perfect manner. When the three inks have been printed on the fixed block, this last is brought in contact with the papers, and the impression is pulled at one operation. Mr. Warnerke has kindly lent me slides illustrating this, and shows photographic prints produced by the same machine. Such a process as this should be able to give results not only with transparent inks, but with opaque inks, where the colors are obtained by dots of the three fundamental colors placed side by side. More, probably, may be heard of this process by and by.

[Specimens illustrating the process of three-color printing were lent by Messrs. Cassells & Company; the proprietors of The Graphic; Mr. Leon Warnerke; Messrs. Waterlow & Sons; and Messrs. Husnik & Hausler, of Prague, through Mr. F. C. Clarkson.]

DISCUSSION.

The chairman, in inviting discussion, said Captain Abney had well explained the principle on which photography in colors was carried out, and there were few more interesting applications of science than that of photography to color printing. They all knew the ordinary chromolithograph, in which a separate stone had to be prepared for every color, or nearly every color, which the artist had employed in his picture, and by successive printings on the same piece of paper the effect was produced. Some very beautiful pictures were produced in this way, and it was rather the pride of the chromolithographer to say how many stones a particular print had taken, and to show his skill in obtaining accurate register, so that all the colors fitted into their proper positions, with no overlapping and no thin white lines where the color did not appear.

One of the chief things which Captain Abney had shown was that all the colors and tints of nature could be produced by combinations of three colors only, and it was an obvious simplification of the process to reduce the numerous printings to three. The pictures kindly lent by The Graphic were interesting illustrations of this fact; being all produced from three colors, which were selected according to the skill and judgment of the worker. This process, however, was only used occasionally, the greater part of their work being still done by the ordinary process of chromolithography. He was informed that there were very few operators on the staff of The Graphic sufficiently skillful to select the three tints and lay them out on the stones so as to produce by their combination the finished pictures such as those exhibited. By means of photography this was done automatically.

Now it was, apparently, a very simple matter by filtering out the different colors from white light, applying the proper screens to divide up the white light into three such portions that you could produce three printing surfaces—stones or blocks—which, by their combination, would give all the colors of the original, but in practice it was a very difficult matter. It was a good many years since they first heard that someone had succeeded, by this process, in obtaining more or less good results; but it was only lately, thanks to the researches of the gentlemen to whom Captain Abney had alluded, Mr. Ives and others, not omitting Captain Abney himself, that such knowledge was gained as enabled the theory to be reduced to practice. He was sorry that none of Mr. Ives' work had been shown that evening, though it had been exhibited there before. It was in that room that Mr. Ives showed the results of his work when he first came from America, and more than once they had had the advantage of seeing there the results of his perfected researches, but still he regretted that through an accident they had no specimens that evening.

He, however, congratulated the members on having had for the first time the opportunity of seeing some of the very beautiful results of Dr. Joly's work. It was rather remarkable that although from the birth of photography the dream of its followers had been to produce photographs in color, and some of the earliest workers did do something in that direction, so little advance had been made in this direction. The only man who really had obtained a photographic picture in natural colors was Prof. Lippmann. He produced a photograph which, when white light was thrown upon it, with proper precautions, reproduced the colors of the original. Others, like Mr. Ives and Dr. Joly, relied on colored media; they did not use the real spectrum, but that imitation spectrum which had been shown that evening, and to reproduce a spectrum by means of properly selected colored media was, in itself, no small feat. It was by such means that the results of Mr. Ives and Dr. Joly and others were produced.

That was not photographing in colors: it was viewing a photograph by means of colored media in such a way as to reproduce the colors of nature. In the same way three-colored printing was not the natural reproduction of color by photography, but the careful selection of colors by photographic means, so as to produce more or less the same appearance as the colors of nature. He hoped Mr. Warnerke would be kind enough to give some further information about the ingenious Russian invention which had been mentioned. As he understood, the principle of it consisted in using three blocks for printing three colors, but instead of printing from those blocks direct on to the paper in succession, each block transferred its ink to a separate roller and from that roller the three different colored inks were again transferred to one single block from which the impression was taken on the paper. The mechanical devices for accomplishing this were complicated and difficult, but when they were overcome there was no difficulty about register, as the whole thing was printed at once.

Mr. L. Warnerke said the principle of the machine had been so clearly described by Sir Henry Wood that he had very little to add. It was invented not long ago, but had already superseded all other machinery in the state paper manufactory in St. Petersburg; as it had so many advantages over ordinary machines used for color printing. In the ordinary way separate blocks had to be used for each color, and after one color had been printed it had to dry before the second could be printed, and so on, and that made it very difficult and in fact almost impossible to get perfect register on account of the different hygroscopic conditions of the air, differences in temperature, etc.; especially when very fine engraving, such as had been shown on the screen, was in question. In this case there was a rotary machine with a large cylinder, on which there was a separate cliché for each color with separate ink ducts, so arranged that, by one revolution of the cylinder, each cliché was inked with its appropriate ink. These inks were transferred to one large composition roller, which in its turn inked the cliché which printed the sheet. There were very perfect arrangements for putting the paper into the machine and for removing it, interleaved with plain sheets to prevent smudging. The peculiarity of the rosette patterns which had been shown, and which were specially applicable to checks and bank notes, consisted in the fact that the very finest lines passed from one color to the other without the slightest break or fault in the register, and of course an enormous variety of designs could be produced by applying different colored inks. On the wall were shown impressions produced from a three-color photographic block. For bank notes sometimes four or five colors were used, but for photographic color printing three were sufficient—blue, yellow and red. The advantages of this method were very great. If one examined carefully some of the finest color prints produced in the ordinary way from separate blocks, one would find a sort of moiré appearance which was entirely absent when this new machine was used. The photographs which had been shown were taken on the spot under some difficulty, and he might say that some fifty of these machines had been at work for the last two or three years.

The chairman said, if no one else had any remarks to offer, he must propose a hearty vote of thanks to Capt. Abney for his paper. There could be no greater treat to anyone interested in these subjects than to see Capt. Abney manipulating the spectrum, because he had a wonderful gift of demonstrating in a practical and lucid manner scientific problems of great complexity and difficulty. That was the great advantage of hearing a lecture in that room. People might read Capt. Abney's papers in the Philosophical Transactions, or his more popular handbooks, but they could not adequately appreciate the phenomena described unless they saw the actual experiments which Capt. Abney was so competent to place before them.

The vote of thanks having been carried unanimously, Capt. Abney, in reply, said he had no doubt that when this paper found its way abroad it would be severely criticised in certain quarters, but he did not mind that, as he was perfectly certain that the principles which he had enunciated were correct.

APPARATUS FOR THE PRODUCTION OF ACETYLENE GAS.

ACETYLENE apparatus in which the carbide falls into water necessitate the use of a special granulated form of the substance. In the state of grains, the carbide is more easily alterable under the action of the humidity of the air or of that of the apparatus itself, and these grains have a tendency to become covered with a layer of lime. The result is that they are not attacked so rapidly as large pieces of fresh carbide, and that it is necessary to throw into the water a larger quantity in order to cause the holder of the gasometer to rise. Manufacturers have, therefore, been led to devise apparatus in which the carbide employed is in the state of irregular pieces. Of these we shall describe two that appear to us to be the most interesting:

1. The "Revolver" Apparatus of the Société du Gaz Acetylene.—The gas generator (Fig. 1) consists of a cylindrical receptacle, A, filled with water up to a level limited by the gage cock, M. Its strongly bolted cover, B, carries in the center a wide charging tube, C, that enters the water to a depth of about three inches. This tube is prolonged above the cover by a hopper, T, above which is placed a distributer, D. A coupling nut, E, fixed to the cover, receives the gas discharge pipe running to the gasometer.

The bottom of the generator, which is inclined toward the orifice of the mud cock, F, in order to facilitate the removal of the residua, is provided with a cone, G, which is placed four inches beneath the orifice of the charging tube, C, and has the effect of distributing the carbide in the bottom of the generator and of preventing the bubbles of gas disengaged in the apparatus from making their exit through this tube.

The gas that is formed accumulates at the upper part of the generator and exerts upon the surface of the water a pressure that causes it to ascend in the charging tube and thus form a hydraulic joint which prevents the outflow of the gas.

The automatic distributer, D (Figs. 2 and 3), consists of a cast iron cylinder divided into a certain number of compartments that receive a charge of carbide capable of producing a volume not exceeding three-quarters of the capacity of the holder of the gasometer.

This cylinder revolves around an axis, O, fixed in the disk, N, which forms the cover of the hopper and is provided with an external groove which is packed with sand saturated with oil. The rotary motion is given by means of a weight, P, suspended from a cord that winds around the cylinder. This arrangement may be replaced by a clockwork movement. The disk, N, which is slightly conical beneath, contains an aperture above which the compartments arrange themselves successively in order to discharge their supply of carbide into it. The revolution of the cylinder is regulated by a lever with cam, S, revolving around an axis fixed in the support, V, and pulled back by a spiral spring, X. In the position shown in the figure, the lower face of the cam prevents the rotation through the intermedium of tappets, n n', cast in a piece with the cylinder.

The motion occurs when the weight, Z, suspended from the holder, rests, through the descent of the latter, upon the disk, n, fixed to the end of the lever and depresses it. The lower part of the cam allows of the escape of the tappet, U, which abuts against it, and, at the same time, the upper face of the cam takes a position for arresting the rotary motion and limiting it to a division corresponding to that of a compartment.

The proper charge of carbide is then thrown into the generator, and the gas that is produced raises the holder, which carries along with it the counterpoise, L. The lever thus liberated resumes its prior position and the lower face of the cam is then in place for the following motion.

The tube, E H (through which the gas enters the holder), and the discharge tube of the gasometer debouch in a box, L, placed at the base of the tank for the reception of the water of condensation carried along in these tubes. This water is removed every week by unscrewing the plug, O, that closes the box.

aqueous vapor in the upper box, B, in which the carbide is placed.

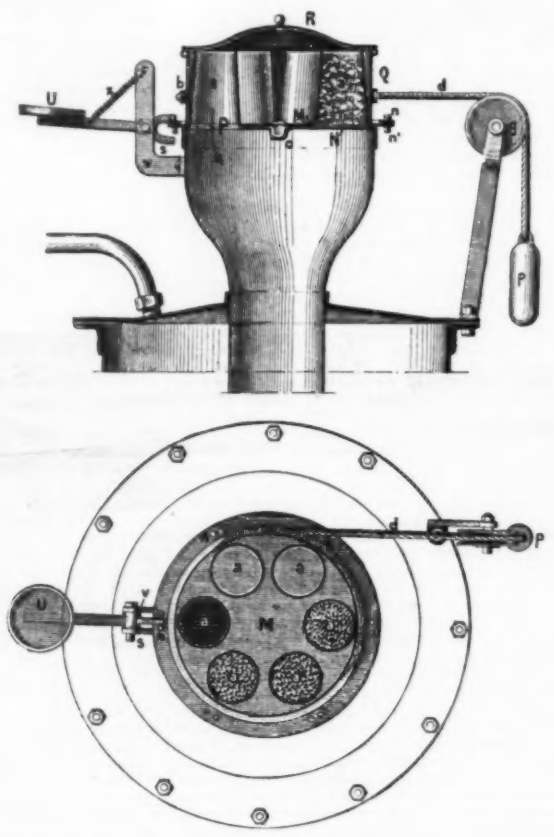
The fall of the pieces of carbide, or rather the motion of the drum, R, which brings it about, is produced through the requirements of the gas holder by the following process (Fig. 5): Upon the axis of the drum, R, revolves a loose pulley, H, which carries the click of a ratchet wheel, h, keyed upon the same axis. The pulley, H, carries along the axis only when it revolves from left to right.

A cord wound three times around the pulley, H, passes over three rollers that revolve between two

serve as a stop for arresting the distributer in any position desired. At its front part the box, B, is closed by a door fixed hermetically by bolts.

The charge of carbide is held upon the distributing rollers by cast iron guides fixed to the upper wall of the box, B. In order to prevent packing the pieces of carbide in their movement, the part, c, of the guides should have as a center the point, i, or a point more remote from i' than the point, i. This curved part terminates in a tangent inclined at an angle of at least 45°. Finally, a slight angle is given the guides, so that the space between them shall increase a little in

FIG. 1.



FIGS. 2 AND 3.

APPARATUS FOR THE PRODUCTION OF ACETYLENE GAS.

The compartments of the distributing cylinder are filled with carbide in irregular pieces. They can be charged even while the apparatus is in operation if need be. The generator is cleaned out every day through the cock, F.

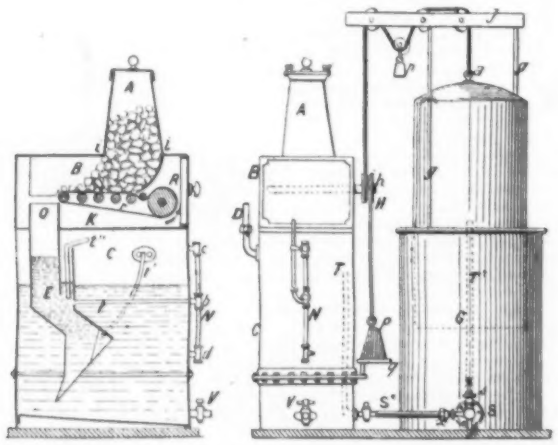
This apparatus is adapted for installations of which the number of burners does not exceed forty. For larger installations, the same establishment is constructing other apparatus that we may perhaps describe at some future time.

2. The Reibel Apparatus.—The apparatus constructed by M. Reibel, of Angouleme, is very simple in principle, and operates continuously. It consists essentially of a gas generator, a gasometer and an automatic distributer. The generator (Fig. 4) has the form of a

disks and is fixed to the upper ring, a, of the gas holder. At its other extremity, the cord carries a weight, P, the travel of which is limited by a tappet, q. A second weight, p, assures the tension of the cord.

Let us suppose the gas holder at the upper end of its travel. When it descends it will begin by raising the weight, p, until the upper part of the cord is horizontal. From this moment the cord will raise the weight, P, and cause the pulley, H, to revolve from left to right. The axis of the drum, R, will be carried along by the click, h, and the belt will carry in front of the orifice, o, of the generator a piece of carbide, which will fall into the water.

In consequence of the production of gas, the holder will immediately rise, and the pulley, H, will revolve



FIGS. 4 AND 5.

parallelopipedon and contains the water necessary for the reaction. The carbide is placed in a bottomless receptacle in the form of a truncated cone. It rests upon an endless leather belt, K, carried by a series of rollers revolving upon pivots and by a drum, R, the axis of which revolves in bearings. A tension roller assures the friction of the belt upon the drum. When the latter turns from right to left, it carries along the belt and causes the fall of pieces of carbide, which drop through the orifice, o, into the generator.

The carbide does not enter the water directly, but traverses a stratum of kerosene, E, which has no action upon it and which prevents the disengagement of

in an opposite direction without carrying along the axis. The weight, P, will rest upon its support, q, and the same series of operations will again take place.

The charging and cleaning are effected without stopping the operation of the apparatus by lifting the cover, A, for the charging and opening the mud cock, V, for the cleaning.

We shall now give a few complementary details as to the different parts of the apparatus.

The distributer is inclosed in the box, B, which is placed upon that of the generator. The supports of the frame of this distributer slide in the box, B, upon two T-irons that form rails, of which the extremities

the direction of the motion of the pieces of carbide.

The conduit, E, is provided with two lead tubes, t and t'. The tube, t, leads the kerosene contained in this part to the point, b, of the level, N. The tube, t', allows of the entrance of water into the apparatus. It terminates externally in an elbow, K. A third tube, t'', which also terminates externally in an elbow, enters the conduit, E, and introduces kerosene into it.

The gas makes its exit from the generator at the upper part of the box, C, through a tube, T, placed to the right (Fig. 5), debouching externally toward the bottom of the apparatus and terminating in a coupling cock, S', connected by a lead tube with the ajutage, S, of the gasometer, G. This ajutage, S, is provided with two cocks, one of which puts the gasometer in communication with the general conduit and the other serves for allowing of the outflow of the small quantity of water that may have condensed during the passage of the gas. The ajutage, S, communicates with the bent tube, T', which rises in the interior of the gaso-

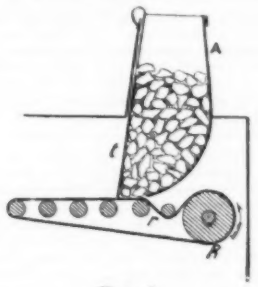


FIG. 6.

meter to the level of the edge of the tank and leads the gas from the generator to the holder. The generator is provided with a three-tube level, N. The central tubulure, b, communicates through the tube, t, with the kerosene inclosed in the conduit, E, and is provided with a pressure gage. The lower tubulure communicates with the water of the gas generator. These tubulures are of brass and are provided with cocks. At the bottom of the lower tubulure there is a small cock which permits of emptying the liquid contained in the level. The apparatus is set in operation as follows:

The elbow, K, corresponding to the tube, t', is connected by a lead tube with a water conduit. From the latter water is introduced until it comes flush with the intermediate tubulure, b, of the level, N. The box, B, containing the distributer being open, kerosene is introduced through the conduit, E, until it exceeds the point, b, by a couple of inches. The introduction of

the kerosene is continued in opening the mud cock, V, in order to keep the level at two inches above b. After the surface of separation of the kerosene and water has descended to half an inch above the lower tubulure, d, of the level, N, the introduction of the kerosene is discontinued. The box, B, of the distributer is then placed upon the box, C, of the generator. When it is not desired to remove the upper box, B, the kerosene is introduced into E by means of a special elbow provided with a screw cover.

All this done, the pulley, H, is put in place in fixing its axis upon that of the drum R, by means of a screw. Then the cord and the weights, P and p, are adjusted. In the next place, the tank of the gasometer, G, is filled with water after the cock of the ajutage, S, serving for the exit of the gas, has been closed and the one that puts the generator and gasometer in communication has been opened. The free surface of the kerosene in the level, N, descends slightly and the surface of separation of the latter and the water rises to about the center of the space between the tubulures, b and d. All that there is to do now is to open the discharge cock in order to expel the air contained in the gas holder.

In order to charge the apparatus with carbide, a plate of sheet iron, t, is placed against the front wall of the hopper (Fig. 6). Then, through the mouth of this hopper are introduced the pieces of carbide, which will be arrested by the plate of sheet iron and be unable to fall into the box of the gas generator. After the hopper is full, the charging plate is removed, the pulley, H, of the distributer is revolved gently by hand until a piece of carbide falls, and the charging with the carbide is finished by filling the interspaces that have formed in the hopper.

In order to set the apparatus in operation, the pulley, H, is revolved very gently by hand so as to cause some of the pieces of carbide to fall. After the bubbling has ceased in the generator, the pulley is revolved again until the large weight, P, rests upon its support.

After the apparatus has operated, it is cleaned in the following manner: The cock through which the water enters is opened and the free surface of the liquid in the level, N, is made to ascend until it comes flush with the lower nut of the tubulure, a. After a few moments of rest in order to allow the lime to deposit, the mud cock, V, is opened to its full extent until the level has descended to the former point, say to about an inch above the tubulure, b. The operation is then resumed until the water makes its exit clear.

The Reibel apparatus, after it has once been started, operates continuously. There is nothing to be done but to charge it and clean it at such times as may be desired. The simplest method of procedure is to perform these operations every day after use. It is better to fill up the space left empty in the hopper than to wait for the total exhaustion of the carbide and effect a complete recharging. On another hand, if the cleaning is done every day, it will take but little time and serve to keep the apparatus in better working order.

The form of the conduit, E, and the superposition of a stratum of kerosene upon the water serving for the reaction constitute a genuine obstacle to the disengagement of the acetylene and of aqueous vapor, which might partially attack the carbide contained in the distributer. The operations of charging and cleaning are performed very simply, without stopping the operation of the apparatus.

For the above particulars and the illustrations we are indebted to Le Genie Civil.

SOUTHWARK AND VAUXHALL WATER COMPANY'S PUMPING STATION AT STREATHAM.

THE pumping plant at the Streatham Works is from the designs of Mr. J. W. Restler, M. Inst. C.E., the engineer to the company, and was constructed by Messrs. James Watt & Company, Soho. It was, we believe, the last work done by the old firm.

It consists of two sets of triple expansion horizontal engines, gearing into countershafts, each countershaft being connected by means of cranks at either end to a set of deep well pumps, and a bucket-and-plunger pump.

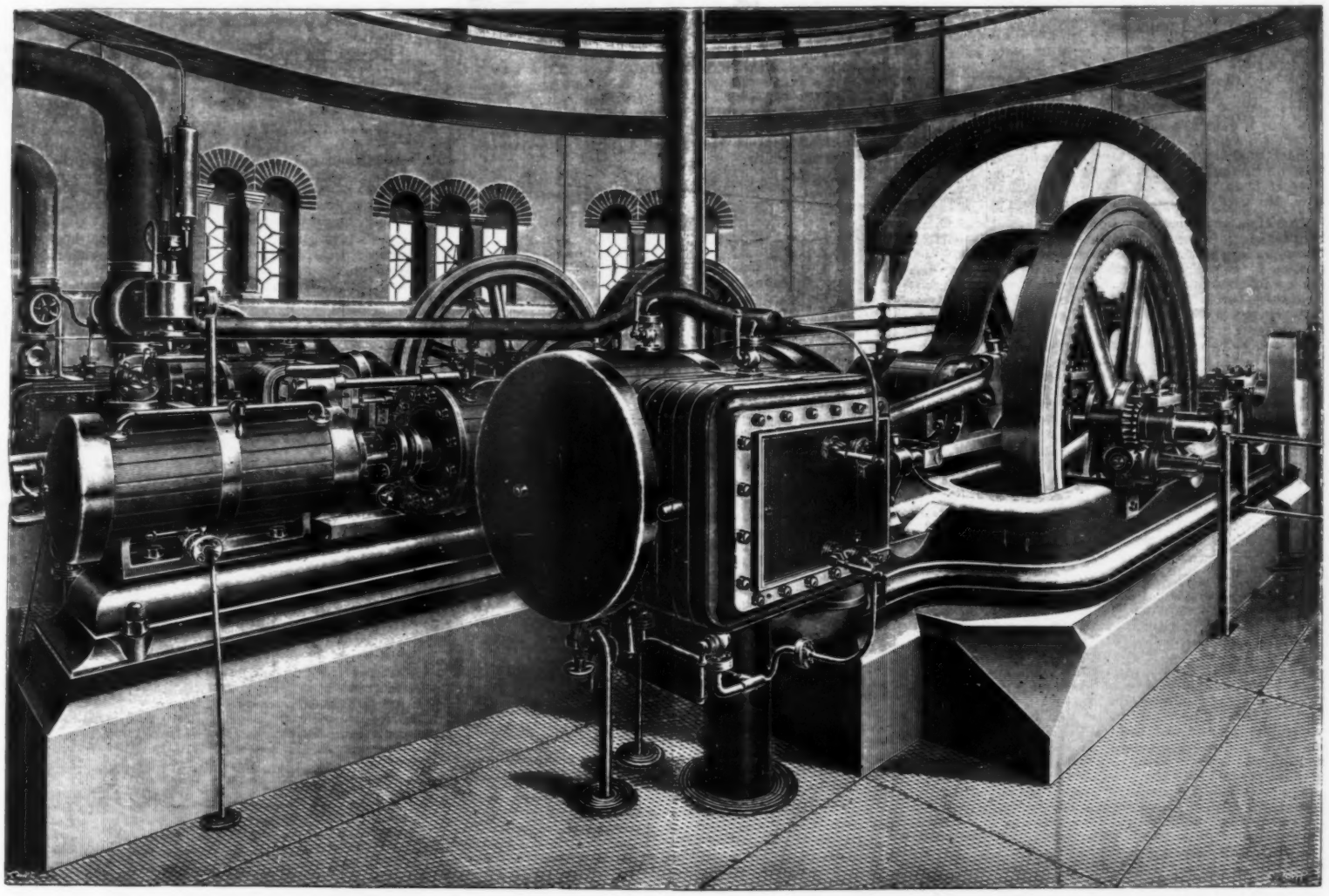
The engine is of the two-crank type, the high pressure and intermediate cylinders being arranged tandem, the cranks being set at right angles. The diameters of the cylinders are 8¾ inches, 13 inches and 25 inches, with a stroke of 2 feet. The cylinders, together with the whole of the valve chests, cylinder covers, etc., are provided with steam jackets, having separate steam and drain pipes to each. The high pressure valve chest is fitted with adjustable slide and cut-off valves of the Meyer type. The engine crank shaft is 6 inches diameter, in two parts, and the countershaft is 8 inches diameter. Cranks are fitted at the end of each countershaft, and these cranks are connected by means of rods to the well pumps and pressure pumps. The engine bed plate is of massive construction and is provided with pedestals for the shafts, having three-part brasses with wedge adjustments.

A surface condenser to each engine is placed on the basement floor and the deliveries from the well pumps are passed through them, a by-pass pipe with valve being fitted on the delivery pipe in order to regulate the amount of circulating water going through the condenser. The air and feed pumps are worked from cranks on the tail end of the engine shaft, and they are mounted over a hot well tank. Each tank is provided with a series of zinc trays, covered with flannel, which are used as a feed water filter. An air charging pump for the purpose of renewing the supply of air to the air vessels is likewise fitted and worked by the air pump rod. The gearing between the engine shaft and countershaft consists of a cast steel helical spur wheel and pinion, the pinions being sandwiched between the coupling flanges of the engine shafts. The diameters of the wheel and pinion are 8 feet and 12 feet respectively, the teeth being $3\frac{5}{16}$ inches pitch, 8 inches wide and shrouded to the pitch line. The well pumps are worked by strong cast steel bell cranks of cruciform section, fitted with polished tension bars and mounted on strong pedestals over the well; the bell cranks are worked from the countershaft cranks by means of tubular steel trussed connecting rods. The bell cranks themselves are connected by built-up rods of H section. All the connecting rod ends are of marine pattern, having phosphor bronze bearings. The pump connecting rods are attached to steel crossheads having roller guides, the pump rods being connected by means of screw couplings to the crossheads.

The well pumps are of the double-bucket single acting type, one bucket working below the other in the same pump barrel. There is an outer tubular pump rod with an inner rod working through it, the outer rod being connected to the upper bucket and the inner rod to the lower bucket. The lengths of pump rod are connected by screwed sockets, those on the outer rod being split and provided with two bolts in each for locking purposes. Lignum vitæ bushes are fixed at intervals inside the tubular rod. The rods are attached directly to the valves, which are in gun metal of mushroom form, the bucket being of cast iron turned an accurate fit to the barrel. The stroke of each bell crank is 5 feet, and as they work in opposite directions the total travel of the buckets from each other is 10 feet. The pumps are 15 inches diameter, the barrels being of cast iron; the barrels are hung from the rising main, which is 22 inches diameter, of wrought iron. These rising mains are carried up to within 50 feet of the top of the well, where they terminate in cast iron pump heads with glands and stuffing boxes, which are supported on girders across the top of the well cylinders; from the pump head the rising mains are reduced to 15 inches diameter, of cast iron, and they are carried thence to the top of the well, and after passing through the condenser, terminate in two glazed brick tanks, which are constructed adjacent to the engine house.

The pressure pumps, which are of the bucket-and-plunger type, are made of the same capacity as the well pumps, and have their suctions connected to the tanks into which the well pumps deliver, the 15 inch deliveries from the pressure pumps being taken to two air vessels, and thence connected to one of the company's trunk mains of 42 inches diameter, which passes close to the pumping station. The well and pressure pumps being made of equal capacity, the draught of water from the tanks is almost equal to that delivered into them, but in order to guard against the overflow of the tanks, or the emptying of the same, should the well and pressure pumps not be working in unison, by-pass valves and pipes are provided, and a warning gage and bell are fitted in the engine house to call attention should the tank become too full or the water too low. The pressure pumps are worked from cranks and connecting rods at one end of each of the two countershafts, the connecting rod actuating the pump being carried down to the bottom of the plunger. The pressure pump buckets are 2 feet 6 inches in diameter and the plunger 1 foot 9 inches, the stroke being 2 feet 6 inches. The bucket and suction valves are of the four beat type, and are of gun metal; the valve seat body is of cast iron, with gun metal seating rings fixed to them by means of screws.

We are indebted to London Engineer for the cut and description.



TRIPLE-EXPANSION PUMPING ENGINE, STREATHAM STATION, SOUTHWARK AND VAUXHALL WATERWORKS, ENGLAND.

ENGINEERING NOTES.

Cast iron cutters for use on milling machines are in successful use in a hardware factory in the United States. According to The Engineer, New York, they do as good work as steel, and cost very little.

Traffic on the Transsiberian railway has already assumed unexpected proportions. It is stated that 7,000 cars would be required to handle the goods now delayed at railway stations. The expenditure required to make adequate additions to the rolling stock is estimated at 60,000,000 rubles (about $32,000,000).—Uhland's Wochenschrift.

Since the practice of providing test holes in the outer ends of locomotive stay bolts has become general, several methods have been adopted for making these holes, says our American contemporary The Railroad Gazette. The first and most common method is to drill the holes after the stay bolts are in place in the fire box and headed over, and for this work light rotary drills driven by compressed air have been largely used. As this, however, is a slow process, many stay bolts are now being provided with end holes at the time the bolts are made, in some cases the holes being punched and in others drilled by means of special machines. Thus the Chicago, Burlington and Quincy and Baldwin Locomotive Works punch these holes, while in the Union Pacific shops they are drilled. When punches are used, the stay bolts are worked hot.

Something new in the way of automatic gear cutting machinery has been introduced by the Brown & Sharpe Company, Providence, R. I. In this arrangement the cutter spindle is rigidly supported on both sides of the cutter and is powerfully and smoothly driven by the spiral gears, thus avoiding the vibration and clattering common in machines driven by spur gears, as well as doing away with a belt tightener or other device for adjusting the belt. The part of the spindle which carries the cutters is exceptionally large, allowing heavy cutters of large diameters to be used; and the changes of cutter speed are easily and quickly obtained by the simple shifting of the belt from one cone to another, thus saving the time and annoyance due to the manipulation of change gears. The cutters are also set from a fixed point, not subject to wear, and thus can always be set central with the work spindle.

The Hamburg-American line has ordered the Vulcan Shipbuilding Company, of Stettin, to build a steamship to eclipse anything afloat in the transatlantic trade, and even to excel the untried but powerful North German Lloyd liner "Kaiser Friedrich," whose builders guarantee her to make half a knot more than the marvelous "Kaiser Wilhelm der Grosse," which has a record for a voyage to Southampton from this port of 22·35 knots. Mr. Emil L. Boas, of the Hamburg-American line, says that the new ship, which will be bigger than the "Great Eastern," has not been named. She will register more than 14,000 tons, and will be 685 feet long, 66¼ feet beam and 44 feet deep. The Vulcan Shipbuilding Company guarantee that she will make 24 knots, which means that she will cover the course between New York and Southampton in 5 days and 9 hours, and the course between Queenstown and Sandy Hook in 4 days and 20 hours. The new ship will be completed in 1900. She will be longer than the famous marine failure, the "Great Eastern;" 37 feet longer than the "Kaiser Wilhelm der Grosse," and about 20 feet shorter than the new leviathan of the White Star fleet, the "Oceanic," which may appear on the seas next summer.

The English newspapers refer to a new process of casting steel proposed by W. Ellis-May, says The Iron Age. The castings are made in an airtight chamber from which the air is exhausted, the mould or casting being placed in the chamber before the exhaustion of the air. A series of other chambers surrounds this chamber, each connected with it by a pipe controlled by valves. In these chambers a reserve of vacuum is stored, the air from them being exhausted by powerful vacuum pumps. When a casting is ready to be run in, the controlling valves are opened and the residue of air in the casting chamber is instantaneously sucked out into the surrounding chambers at the same moment that the molten steel is poured into the mould. The casting thus takes place in vacuo, the occluded gases rush out of the fluid metal and diffuse themselves in the vacuum chambers and a flawless, homogeneous steel casting is the result. In the case of large ingots or armor plates the process provides additionally for subjecting the fluid metal to uniform compression by means of hydraulic power while in vacuo, so that cavities which might result from contraction of the metal while cooling will be rendered impossible. It is usual at present when making large castings to use about 40 per cent. more metal than is required for the work, because the upper part of the ingot, being permeated with air and gas bubbles, has to be cut off and discarded as useless. By the Ellis-May process it is claimed that this waste will be avoided.

An official return of the English firing practice carried out at sea during the past twelve months has been issued, says Public Opinion. The results are recorded of 102 vessels, and the best record is that of the first-class cruiser "Imperieuse," flagship on the Pacific station. This vessel carried out her practice with her 9·2-inch 32-ton breech-loading guns, and out of 27 rounds made 22 hits, giving her the exceptionally high average of 81·5. The next best record is that of the third-class cruiser "Porpoise," on the China station, which scored 31 hits from 46 rounds, fired from her 6-inch breech-loaders, giving her an average of 67·3. She is followed very closely by the third-class cruiser "Blonde," on the Cape of Good Hope station, which, using her 4·7-inch quick-firing guns only, scored 37 hits out of 55 rounds, giving her an average of 67·2. The fourth in order is the first-class gunboat "Karrakatta," on the Australian station, which scored 12 hits out of 18 rounds with her 4·7-inch quick-firing guns, and gained an average of 66·6. Seven first-class battleships had their practice with 67-ton guns, these being the "Anson," "Hood," "Howe," "Camperdown," "Nile," "Ramillies," and "Rodney," all on the Mediterranean station. The "Camperdown" attained the highest average, viz., 40, scoring 6 hits from 15 rounds; the other records being: "Anson," 16 rounds, 5 hits; "Hood," 23 rounds, 7 hits; "Howe," 16 rounds, 3 hits; "Nile," 22 rounds, 7 hits; "Ramillies," 25 rounds, 8 hits; "Rodney," 16 rounds, no hits.

ELECTRICAL NOTES.

Bangkok, the capital of Siam, will soon have electric light. A company with a capital of $140,000 has been formed there, and has secured a concession for twenty years.—L'Industrie Electrique.

It is reported that, according to French law, upon the expiration of the franchise of an electric railroad company, the entire line, with all power stations, becomes the property of the state.—L'Industrie Electrique.

In repairing a cable off Cape Frio a whale was found entangled in it, by the cable ship "Norseman," but it had not broken. The whale must have been there for two or three weeks and had been bitten into by sharks.

According to The London Electrician, two towns, Hammerfest and Tromso, within the Arctic circle, have electric light plants. These plants must have a very satisfactory power factor during the long nights of the winter season.

The total length of the world's telegraph lines has reached 4,908,921 miles, exclusive of 180,440 miles of submarine cables, says The Electrical World. Of this, Europe has 1,764,799 miles; Asia, 310,685; Africa, 99,419; Australia, 217,479; and America, 2,516,548.

The Swedish government has under consideration a plan for the electrical transmission of 20,000 horse power from the falls of Elfkarleby to the capital, Stockholm, a distance of nearly 100 miles. As the falls could readily furnish 100,000 horse power, an extension of the plant can be readily made if necessary. The cost will be about $2,000,000, and the yearly receipts are estimated at $150,000.—Elektrotechnische Rundschau.

It has been observed in several instances that X rays have a peculiar action on the skin, causing it to get red and sometimes black, and also causing the hair to fall out. These effects, as well as other troubles resulting from the action of X rays on the human body, can be cured, according to Dr. W. Gebhardt, by an electric light bath, the light of an electric arc lamp being thrown upon the diseased parts.—Elektrotechnische Rundschau.

On August 8 last was unveiled, at Frankfort-on-Main, a statue of the Frankfort physician, Samuel Thomas von Soemmering. Dr. Von Soemmering's name is well known in connection with the early history of telegraphy. The statue, which has been executed by Petry, is a life sized figure of Soemmering, and next to him is represented an electric battery connected to his electro-chemical receiver. The granite pedestal of the statue bears the words "S. Th. v. Soemmering, Erfinder d. elektr. Telegraphen."

The central electric lighting stations in the United States, according to the "American Electrical Directory," now number 2,594. Of this number 2,261 are owned and operated by private corporations, firms and individuals, while 333 are municipal plants. The former represent an investment of $229,938,605, and include 264,428 arc lamps and 7,234,134 incandescent lamps, requiring 970,481 horse power of engines. The latter include 26,087 arc lamps, 371,440 incandescent lamps, and require 67,740 engine horse power for operation.

In a recent interview Mr. Herbert Laws Webb quoted the following answer of Preece in reply to a query as to how he managed to accomplish so much work as he is known to do in one day: "Well," he replied, "I always go to bed regularly at 11 o'clock at night and I always awake regularly at 4 o'clock in the morning. Before I gave up smoking I was always drowsy on awaking. I stopped smoking seven or eight years ago, and now I wake instantly and am ready for work. I sit up in bed and put in from four to seven hours at whatever I have in hand. It is a splendid way of adding 40 per cent. to the working day." "Whatever he has in hand" may be the process of a new invention, a monograph on some scientific subject, or an argument on ocean telephony. Nearly all his original papers were written in this manner. But when he goes to the post office, he endeavors to forget his early morning work for the time being at least. The evening is generally put in in lecturing or at the meeting of some scientific society.

In 1899 there will be held an international electrical exposition at Como, Italy, to celebrate the hundredth anniversary of the invention of Volta's pile. Sig. E. Jona, in an article in L'Elettricita, proposes that this should be made a special exhibition of batteries of all forms. For a long time the battery was the only source of electricity, and despite the perfection of dynamos, has yet many useful applications. By bringing together all the various types of batteries and properly classifying them, an exhibit of great interest would be secured. It would also be possible, he thinks, to thus amass a battery of perhaps 100,000 cells or more, with which a number of valuable and interesting experiments might be made. It seems rather unfortunate, says The American Electrician, for the proposed exposition that its date falls between that of the Turin fair this summer and the great show at Paris in 1900, and this suggests the thought that we might possibly dispense with a few of the international expositions that are being exploited every month or so.

A committee of the Academie des Sciences was formed at the instance of the French minister of war to investigate the question of fixing electrical conductors in or near powder magazines, and their report has been presented. They make no distinction between telephone and telegraph wires and electric light and power conductors, since all these may be exposed to lightning. According to Industries and Iron, the report may be summarized as follows: All underground electric conductors, as well as gas and water pipes, must be kept at least 30 feet away from the magazine. Aerial lines must be arranged so that they will not fall upon the magazine if broken, and it is recommended that none be allowed within 60 feet of the magazine. If light be required inside the magazine, all wires are to be in strong metallic pipes and all switches, fuses, etc., are to be placed on the exterior of the building. Only fixed lamps are permissible, and these must be protected by a second envelope of glass. No voltages over 110 are to be used. Any electric bells required must be placed at least 12 feet from the powder and only types using very small currents are permitted.

SELECTED FORMULÆ.

Printing Press Rollers.—To eight pounds of transparent glue add as much water as will just cover it, and occasionally stir it during seven or eight hours. After standing twenty-four hours, and all of the water is absorbed, submit it to the action of heat on a water bath until the glue is all dissolved. Remove from the fire as soon as froth is seen to rise, and mix with it seven pounds of molasses previously made tolerably hot. Stir the composition well together while heating, but do not allow to boil. After being thus exposed to the heat for half an hour, and frequently well stirred, it should be withdrawn from over the fire and allowed to cool a short time, previous to pouring it into a cylindrical mould made of tin, tinned sheet iron or copper, having a wooden cylinder previously supported in its center by means of its end pivots or gudgeons. After remaining in the mould at least eight or ten hours in winter and a longer time in summer, the roller is to be taken out of the mould by means of a cord fastened to one of the gudgeons, and passed over a stone pulley fixed to the ceiling. Old rollers are recast in the same manner, first taking care to wash them with a strong alkaline lye and adding a small quantity of water and molasses. The best mode, however, of making use of the old composition is by mixing it with a fresh batch made of two pounds of glue and four pounds of molasses.

(2) The Scientific American Cyclopedia of Receipts gives the following formula for the "mysterious black composition, so durable and elastic, and known to but few persons until recently:"

Best glue	10½	pounds.
Black molasses or honey	2½	galls.
India rubber, dissolved in oil of turpentine	1	pound.
Venice turpentine	2	ounces.
Glycerin	12	"
Vinegar	4	"

Purified India rubber only is used. To recast, add 20 per cent. of new material.

(3) Take an equal quantity of good glue and concentrated glycerine; soften the former by soaking it in cold water, then melt it over a water bath, gradually adding the glycerine. Continue the heat until the excess of water has been driven off, meantime constantly stirring. Cast in brass or bronze moulds, well oiled.

(4) Strong, medium weather rollers:

Cooper's best glue	8⅓	pounds.
Extra sirup	2	galls.
Glycerine	1	pint.
Venice turpentine	2	ounces.

Steep the glue in rain water until pliant. Drain it well. Then melt it over a moderate fire, but do not "cook" it. This step in the process takes from 15 to 25 minutes, when the sirup is added, the mixture boiled for three-quarters of an hour, stirred occasionally and the impurities arising to the surface skimmed off. Add the glycerine and Venice turpentine a few minutes before removing from the fire, and pour into the moulds slowly. Slightly reduce or increase the glue as the weather becomes colder or warmer.—Pharmaceutical Era.

Egg and Custard Powder.—The following formulas are said to be employed by manufacturing bakers:

EGG POWDER.

Sodium bicarbonate	8	ounces.
Tartaric acid	3	"
Cream tartar	5	"
Turmeric, powdered	3	drachms.
Ground rice	16	ounces.

Mix and pass through a fine sieve. One teaspoonful to a dessertspoonful (according to the article to be made), to be mixed with each half pound of flour. Two teaspoonfuls equal one medium sized egg.

CUSTARD POWDER.

(1) Arrowroot	8	ounces.
Corn flour, best	7	"
Saffron, powdered	10	grains.
Oil bitter almonds	24	drops.
Oil nutmeg	12	"

Mix the powders in a mortar, gradually add the oils and pass through a fine sieve.

(2) Arrowroot	8	ounces.
Rice flour	8	"
Gum tragacanth	1¼	"
Powdered turmeric	2½	drachms.
Oil bitter almond	20	minims.
Oil lemon	20	"
Oil nutmeg	10	"

—Pharmaceutical Era.

Prevention of Halation in Photography.—The Chemist and Druggist says that for this purpose "the usual thing is a mixture of burnt sugar, sienna and gum, than which a more unpharmaceutical product cannot be imagined. It answers the purpose well, but does much damage to dark slides, and causes, by its messy character, many failures." Instead, our contemporary recommends the following:

Hard soap (in fine shavings)	⅛	ounce.
Alcohol	10	"

Digest at a temperature not exceeding 70° F., agitating occasionally, for seven days; filter and dissolve in the filtrate:

Erythrosin	50	grs.
Aurin	50	"

This fluid is painted on the back of the plate, and, drying in a few minutes, affords efficient protection against halation. It is wiped off with a damp rag before developing. The formula might be improved, it is added, by the addition of some compatible dye, so that the fluid might be visible in the red light of the dark room.

Dressing for Russet Leather.—

Soft soap	2	oz. av.
Linseed oil	3	fl. oz.
Annatto solution (in oil)	8	"
Beeswax	3	oz. av.
Gum turpentine	8	"
Water	8	fl. oz.

Dissolve the soap in the water and add the annatto; melt the wax in the oil and turpentine and gradually stir in the soap solution, stirring until cold.—Bulletin of Pharmacy.

PATENTS.*

By JAMES W. SEE, Hamilton, Ohio, Member of the Society.

THE special law books deal thoroughly with the subject of patents, but such books are too voluminous for use as working tools by the members of the society, many of whom have to do largely with patent matters. Again, unfortunately, there are certain matters connected with patents which are generally ignored by the text book writers on the professional theory that they involve truisms not calling for discussion. And it is on these ignored matters that engineers and manufacturers, constantly in contact with the subject of patents, seem often to go astray. For instance, it is astonishing how often the intelligent manufacturer expresses an anxiety to get a patent on some new product so that he can begin its manufacture without danger of infringing upon other patents. The following remarks are designed to avoid discussion of controversial points; to be generally on the safer side in questionable matters; to deal only with questions on which inventive mechanics and manufacturers ought to be posted for purposes of everyday work with inventions; and to treat the subjects from the practical view of the shop, experimental room and office. The particular points herein considered may be briefed as follows:

Preliminary examinations are of merit in certain cases only.
Caveats are generally misunderstood.
Hurried applications are generally unwise.
Inventions are not easily stolen.
The first meritorious inventor prevails.
A patent is not a license.
Joint invention is often misunderstood.
Employers' rights are often misunderstood.
Change of purpose is not patentable.
Combination claims are good claims.
Aggregation is not invention.
Specific claims should supplement generic claims.
Subcombinations are patentable.
The doctrine of mechanical equivalents inures to pioneers.
Modifications should not generally be set forth in patents.
Divisional applications are wise and often necessary.
A superior patent solicitor is not necessarily the best for all classes of cases.
The contingent fee system is generally but not necessarily bad.
Infringement cannot always be determined from the face of the patent.
The government cannot insure the validity of a patent.
Patent copies and digests are useful tools.
Foreign patents should be contemplated with caution.

PRELIMINARY EXAMINATIONS.

If an application is filed for a patent, it may become rejected on flat references which, if known in advance, might save the entire expense of the application. Some months generally elapse between the filing of the application and the reaching of it for official examination, the inventor during this time being in doubt as to where he stands and as to the advisability of spending money in promoting the invention. Hence the idea of a preliminary examination into the novelty of the invention. In some lines of invention it is possible to look up all of the patents in that line, and thus get a general notion of the prospects. If a flat anticipation is encountered, then the matter may be dropped. The expense of the preliminary examination is but a few dollars, and may be the means of saving the cost of an application and of promptly showing that no further hopes need be had. But preliminary examinations are of respectable value only when they do succeed in bringing out such flat anticipations. If they do not develop anticipating matter, it does not follow that the exhaustive official examination will not do so. No cheap preliminary examination can extend beyond United States patents, thus leaving foreign patents and literature and pending applications entirely unsearched, nor can preliminary examinations contemplate with any satisfactory degree of certainty the position which may be taken by the officials as regards questions, aside from novelty, of aggregation, non-invention, etc. Preliminary examinations can be made only where the invention can be searched for in well defined classes. Where the invention is liable to be buried in noncognate classes, or in an enormous number of classes, no reliable cheap examination can be made. Many cases occur in which it is impossible to say that anticipations of the invention should be looked for in certain classes of patents, and not elsewhere. For instance, a given detail of mechanism, invented with special reference to a steam engine governor, might be found in connection with unthought of textile machinery, or a cord guiding device for a steam engine indicator might be found fully anticipated in some patent for the rigging of ships. By "cheap" preliminary examination, I mean an examination whose low costs will justify its being made for the purpose of possibly saving the expense of an application. Even where an invention might be searched for in well defined classes, slips may occur by reason of broken sets of patents in the portfolios of the Patent Office. It has often happened that a conscientious search through a given subclass in the Patent Office has indicated a clear field, and that the subsequent official examination resulted in a flat reference, which belonged in that subclass and belonged nowhere else. In other words, this reference should have been found during the preliminary examination. But it has developed that the portfolio was incomplete. It is the aim of the Patent Office to keep them complete and to surround them with reasonable safeguards, but rascally searchers, with the desire to save the trifling cost of a copy of a patent, are able to abstract copies and leave the portfolios incomplete. These portfolios, altogether, contain over a half million patents, and there seems no reasonable way to insure their constant completeness. With a view to possibly saving the cost of an application, and with a view to prompt information on which to found hope or despair, it is advisable to make preliminary examination in case the invention will fit into fairly defined classes of patents, but not otherwise.

CAVEATS.

Many inventors seem to have a notion that a caveat is a provisional sort of a patent; that it constitutes title to property in inventions; and that it is a quick and cheap method for securing temporary protection. This is all wrong, for caveats fulfill none of these conditions. When an inventor contemplates the production of an invention along a given line, and where he fears other inventors might have or get, properly or improperly, similar ideas, and beat him in the race of diligence in completing the invention, he may make up a description of his incomplete invention, observing proper formalities, and lodge the same in the secret archives of the Patent Office on payment of a fee. The caveat term is one year, and may be renewed from year to year by the payment of annual fees. No patent will ever be granted to him as a result of the caveat. The filing of the caveat is no evidence that the caveated invention is new or patentable. No examination is made by the Patent Office into the novelty or patentability of the subject matter of the caveat. The caveat is utterly without effect as regards the rights of the public or of other inventors. The sole purpose of the caveat is to secure notice to the caveator in case a competing inventor applies for a patent, thus giving the caveator an opportunity to complete his invention and file his application and establish such rights as he may be entitled to. If during the caveat period an application is filed by a stranger seeking a patent on the subject matter of the caveat, such application will be suspended, and the caveator will be given notice, and will be given three months in which to file a proper application for a patent, whereupon interference proceedings will be had to determine the question of priority. The caveat will not comprehend competing applications already on file before the caveat. It is advisable to have nothing to do with caveats, but to accomplish the caveat purposes by means of an application for a patent, for it is only in rare cases that matter can be described in a caveat which cannot be put into satisfactory provisional form for the purposes of a formal application. The preparation and filing of a caveat costs nearly as much as an application; its period is but one year without additional fees; it provokes no official examination, and therefore gives no notion of the prior state of the art, and it can never eventuate in a patent. A formal application, made for mere caveat purposes, costs but little more than the caveat; it provokes an official examination into the state of the art, and thus serves to indicate whether or not its subject matter is new and patentable; it brings about the same notice and interference proceedings with any competing applicant, regardless of whether the competing application is earlier or later than the application in question; the application may be caused to eventuate in a patent if the matter is patentable and in satisfactory form; the application can be delayed within reasonable limits while the invention is being perfected, or in the end the application may be abandoned in favor of a later application for the invention in its more perfected form. An application has a further advantage in the fact that in case of interference proceedings it may give the applicant the benefit of the senior date of filing, and thus throw burdens of opening proofs upon his competitor, while in the case of an application following notice under a caveat the caveator's application is bound to be of junior date. Briefly, a caveat does nothing that an application does not do, and an application does much that a caveat cannot do.

HURRIED APPLICATIONS.

Many inventors produce an invention and then seek a patent without delay, the result often being that the invention is patented in half-baked condition and must be followed up by later patents on more perfected forms, and that commercial experience may prove the invention a failure, and often the premature application results in such exposures as will preclude the later getting of patents with claims of adequate scope. The only advantage of the prompt application is that it enables an inventor to ascertain whether or not he is working in an old field. An application filed merely for the purpose of ascertaining the state of the prior art had often better be allowed to slumber while the invention is being mechanically and commercially developed. An inventor loses none of his rights by delaying his application for a patent.* The law gives the inventor a period not exceeding two years in which to publicly exploit his invention before applying for his patent. He may sell the patented invention by the thousands without affecting his rights to the patent, so long as he applies for it within two years from its first publication by print or sale. During this period he may test the market and may improve his invention, and when he applies for his patent he may cover the invention in an improved form. Furthermore, the effect of the delay has been to give a later date to the patent, thus prolonging the date of its expiration nearly two years. If infringements develop during the period in question, then it may become advisable to avoid further delay in applying for the patent.

An exception should be noted regarding this matter of delaying the application. There is a class of inventions which might be called bubble inventions, or those which will sell for a short time only. Toys and advertising devices often come under this head. Such an invention, if put upon the market without patent, might provoke enterprising competitors having superior facilities and capable of getting all of the cream off the business before the patent could be procured. Such inventions should be patented before they are exploited. Briefly, get the patent as quickly as possible, if the commercial life of the invention is likely to be a short one, but otherwise delay the application, within the two-year period of exploitation, with a view to having the patent embody developed improvements, and with a view to prolonging the protected period.

STEALING INVENTIONS.

Ideas can be stolen from the originator. But there is no excuse for inventions being stolen. An idea is not an invention, but is merely a hopeful conception of a possibility. The invention is the possibility reduced to form. Many men have ideas which are mere visions and which never can be given form by anybody; other men have ideas which they would be incapable of reducing to form themselves, but which could be reduced to form by others if the idea was disclosed. The mere hint or idea is of no benefit to the public, and is not the thing which the law seeks to reward. The useful invention is the thing which is recognized. It is quite common, when a meritorious inventor has gotten his patent, to hear numerous men say, "He stole that from me," when the fact was there was nothing to steal, no invention, but merely an idea. As an example:

Let A, in talking to B, suggest the high desirability of a balloon which could go to the moon, B never having thought of the subject before, and A never thinking of it again. In a year or two, B, having wrestled with the subject, discloses and patents a system by which a balloon carries certain chemical charges acting in conjunction with atmospheric elements and rendering it possible to recharge the balloon with gas indefinitely, so that it can go to the moon. A will solemnly assert that B stole this invention from him, when the fact was that there was no invention until B made it. Even if A was able to make the invention, he showed no disposition to do so. The law rewards him who accomplishes something instead of him who merely suggests the desirability of a certain accomplishment. Regardless of who first conceives of the desirability of an invention, he who actually makes the invention first is the one entitled to a reward. If the inventor of an idea does not wish to be beaten out of the reward, let him keep the idea secret and act upon it, and if a competitor appears to exist, diligence must be shown in order to prevail against the competitor. The idea of an invention, followed by occasional and half-hearted attempts to reduce the thing to the form of an invention, will not prevail against the meritorious inventor who, though later to conceive, or even borrowing the idea, was the first to reach the goal of practical accomplishment which benefits the world.

But if an inventor has gone further than the idea, and has developed it into an invention, then the only way he can lose his rights is to keep it secret, so that he cannot prove that he had any rights. The originator of an invention who has reduced it to an actual useful invention, and can prove that fact, cannot be deprived of his rights. A competing inventor may meet him in the Patent Office with an application, or the competing inventor may actually get his patent before the meritorious inventor has applied for his patent; but if the facts are susceptible of proof, the meritorious inventor, after proper interference proceedings, will be adjudged his rights and will get his patent, and the patent of his competitor will be practically void.

Briefly, then, keep ideas of invention secret, for fear a more enterprising man, acting on that idea, may be the first to actually evolve an invention from it; be not so secret as to exclude knowledge from friends who may be needed to make proof of dates and diligence; be diligent in reducing an idea to a practical invention; when the idea is reduced to a practical invention avoid secrecy, so as to have ample proof of the fact.

FIRST INVENTOR.

In conflicts between interfering inventors, both seeking a patent on the same invention, he is the first inventor and entitled to the patent who has best done his duty by the public whose reward he seeks. This duty cannot be measured by any fixed standard, and each case must stand largely on its own merit. If an inventor has been diligent in pushing his conceived invention forward into a condition where it is in a position to advance the useful arts, he is not to be deprived of his reward by dilatory earlier conceivers, who have gone only so far as mere disclosures or sketches or drawings, or abandoned experiments or abandoned caveats. Priority of conception must be coupled with reasonable diligence. If there is no negligence on the part of the first inventor, the second inventor, though the first to reduce the invention to practice, will not prevail. An application for a patent is construed in law to be a reduction to practice. The first inventor is, therefore, either he who first conceives the invention and follows it up with reasonable diligence or he who conceives later than a negligent inventor and first reduces the invention to practice.

A PATENT IS NOT A LICENSE.

Many manufacturers labor under the mistaken impression that, if they patent some new machine, they are therefore free from the possibility of infringing on other patents. It is astonishing how common this error is, and how many manufacturers are in a hurry to get a patent, in order that they "may make the thing without danger from others." An original and meritorious patented invention may be dominated by some previous patent. A patented invention may be improved by a subsequent inventor, and most inventions are improved from time to time, but the improver acquires no rights under the fundamental patent by reason of having improved the fundamental invention. You cannot put your saddle on another man's horse, and thereby claim the right to ride that horse.

And the inventor of the improvement, having exer-

*To be presented at the Niagara Falls meeting (June, 1898) of the American Society of Mechanical Engineers, and forming part of Vol. xix. of the Transactions.

*We must strongly dissent from the statement that "An inventor loses none of his rights by delaying his application for a patent." On the contrary, delay in filing an application may defeat an inventor, if another inventor subsequently conceives the same invention and promptly files his application or reduces the invention to practice. It is settled that where an inventor has completed his invention, if he neither applies for a patent nor puts it to practical use, a subsequent inventor, who promptly applies, is entitled to the patent, and the first one is deemed to have abandoned his rights. See Pattee v. Russell, 3 O. G., 181; Ex parte Carre, 5 O. G., 30; Johnson v. Root, 1 Fisher, 351.

Again, although a patent is granted to the first inventor, not necessarily to the one first to file an application, the subsequent applicant, in order to overcome the date of filing of the earlier application, must prove a reduction to practice prior to the filing of the first application. Beals v. Finkenbiner (Court of Appeals, District of Columbia) 82 O. G., 598.

So, also, "Although F was the first to conceive, D was the first to reduce to practice, and, as F did not use due diligence in perfecting the invention, held that D should be awarded priority." Dodge v. Fowler (Court of Appeals, District of Columbia), 82 O. G., 505.

That the filing of an allowable application is equivalent to a reduction to practice, see New England Screw Company v. Sloane, MacArthur's Patent Cases, 210, as follows: "As to the last ground of argument on the subject of reducing the principle of the invention to a practical or useful result, I think the rule laid down by Judge Cranch may be considered as correct. That where the invention is not of a mere philosophical speculation, abstraction or theory, but of something corporeal—something to be manufactured—the applicant need not show that he has reduced his invention to practice otherwise than by filing his specification and furnishing drawings as required by the statute."—Ed.

cised the talent of invention and having advanced the useful arts, is just as much entitled to a patent for his improvement as the fundamental inventor was for his fundamental invention. It might be asked if it was not folly to patent an improvement which could not be used in view of a dominating patent. The answer is, that improvement patents are often as valuable as fundamental patents, by reason of their expanding the market for the fundamental invention by increasing its capacity or lessening its cost. It is true that the owner of the fundamental patent may be the only possible customer for the improvement patent, but it often happens that the improvement is important or even essential to the financial success of the fundamental invention. Again, it may develop, in course of time, that the fundamental patent is invalid for some reason, and in any event the fundamental patent will expire while the improvement patent is in force.

JOINT INVENTORS.

Where an invention is the result of the joint efforts of two or more parties, all the inventors must join in applying for the patent. Where an invention is the result of the effort of a single inventor, he should not join with him anyone who has merely exercised mechanical skill in carrying out his instructions in developing the invention, or anyone who has joined him in a financial or proprietary capacity. In case the skilled mechanic has been called on by the inventor in developing his invention, and a doubt arises as to whether or not the skilled mechanic has or has not exercised some act of invention, doubts should be resolved in favor of the skilled mechanic having done so, and he should join in the application, the fundamental inventor securing himself by proper preliminary contract with the mechanic, and by deed of assignment under the application. Questions of personal pride in connection with patents should always give way to legal considerations of the validity of patents.

(To be continued.)

"**The American** locomotive is becoming an important factor in the United States export trade," says The Age of Steel. "The statement is made that during the past six months not less than 300 American locomotives have been ordered on foreign account. This has been accomplished in the face of severe competition, in which European builders have stoutly pressed their claims. The reasons for preference have not been altogether a question of cheapness. Other considerations have led up to the conclusion of contracts. In appearance, ease of handling, combination of lightness with strength, and in the methods of furnishing interchangeable parts by which an injury to one can be promptly met by having its counterpart in easy reach—all these are factors in building up the reputation of the American locomotive. Duplicate pieces are generally ordered and kept in stock till required. It may be that the engineering strike in Great Britain has been an indirect cause for a displacement of orders, but the fact remains that the American locomotive is becoming increasingly popular in foreign countries."

NEW CAMP EQUIPMENTS FOR THE GERMAN ARMY.

THE care of troops while in the field is one of those perplexing problems whose solution has caused considerable difficulty to army leaders of all times. Of the increase of baggage and other *impedimenta* of an army connected with the solution of the problem, the great Julius Cæsar himself bitterly complained; but, nevertheless, matters were considerably simplified in ancient times. It was well understood that a full stomach was the best equipment of a soldier during war, but no one wasted a thought on the wounded warrior. Modern wars, however, have brought about a complete change in this respect, and to-day the wounded and unharmed are provided for with equal care. It is, therefore, evident that the difficulties to

FIG. 1.—COOKING TENT.

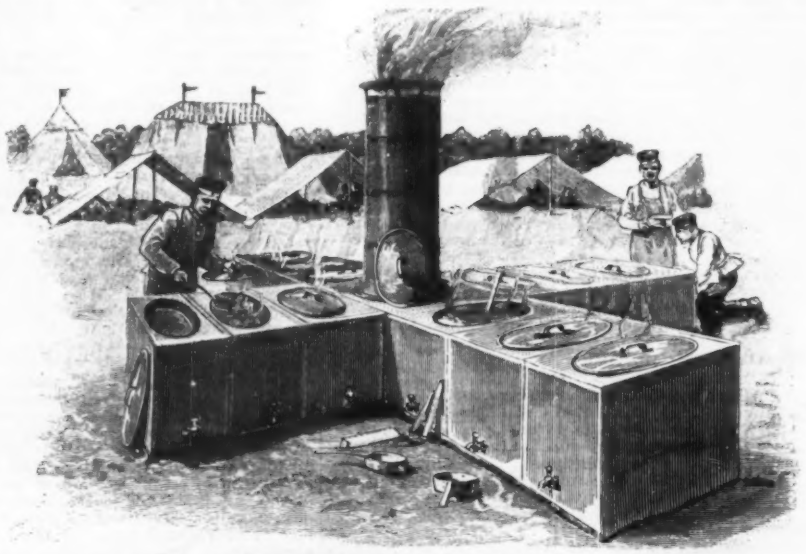


FIG. 2.—THE CAMP COOKING APPARATUS OF A BATTALION.

FIG. 4.—A COMMANDER'S TENT, WITH A CHART TABLE.

FIG. 3.—CAMP STOVE FOR THIRTY MEN.

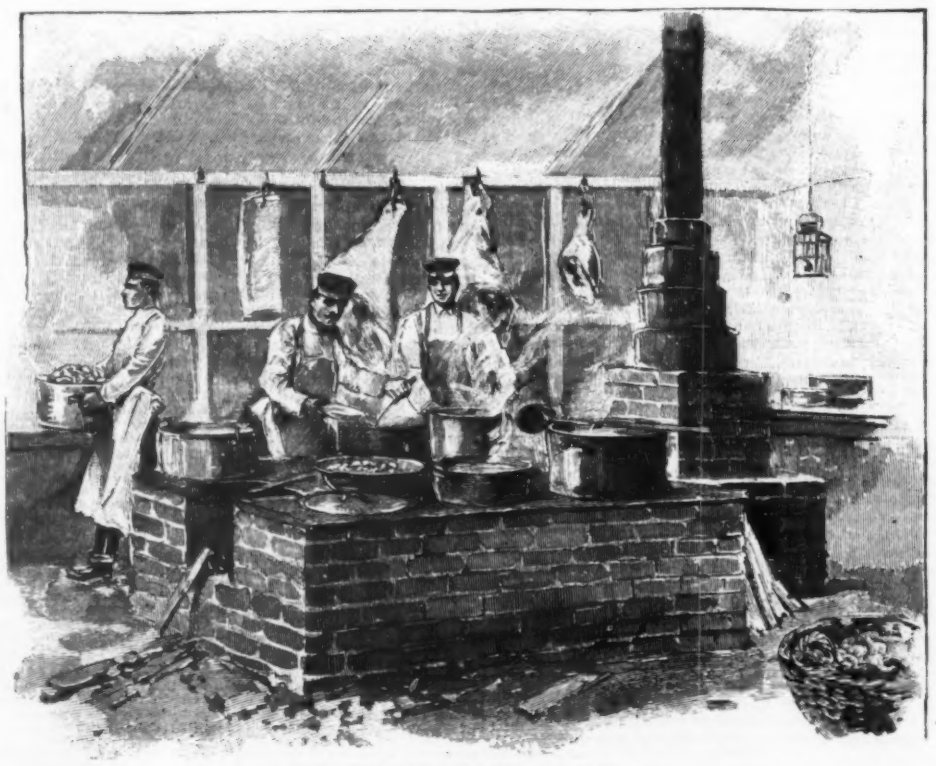


FIG. 5.—CAMP COOKING STOVE.

be encountered in caring for troops are far greater than they formerly were. The efforts of the war departments of all nations in bringing about better conditions are supported with praiseworthy zeal by public and private institutions. The general interest taken in promoting the welfare of the army is proved by the exhibition held toward the end of last year in the Messpalast of Berlin in Alexandrinenstrasse. Although the various appliances there shown for equipping the army were largely of a theoretical value, the practical worth of which could only be ascertained by actual use, we have, nevertheless, considered it worth while to present several sketches of models exhibited at the Messpalast.

We first see before us a large cooking tent (Fig. 1), sufficient for the needs of an entire battalion. The waterproof pieces of canvas are fastened down by the usual poles, laths and pegs; the chimney, which extends smoking through the top, announces from afar the purpose of the tent. The interior presents the appearance of a very comfortably furnished kitchen. Hanging on iron hooks round the walls of the interior are delicious pieces of meat; toward one side there stands a heavy potato and vegetable chest. The chief decoration is, however, presented by a magnificent iron Dutch-tiled cooking stove which would excite the envy of every great city hotel-cook. Another good feature of the cooking tent is its portability, enabling it to be packed upon a specially constructed wagon from which it may be unpacked and set up for only a single bivouac. Fig. 2 represents a camp cooking apparatus for a small battalion. The stove is uncovered, cross-shaped, and formed of iron chests, with a chimney extending upward from the center. Fig. 3 represents a camp stove large enough to cook the food of thirty men. Fig. 4, a commander's tent with a chart table, and Fig. 6 an officers' summer tent, require no further explanation. The stable tent pictured in Figs. 7 and 8, it seems hardly necessary to remark, is not meant to shelter the horses of an entire troop, but only the costly steeds of the officers. The exterior as well as interior arrangement of such a tent is visible from the drawing. Coming now to Figs. 9 and 10, we see what provision has been made for the sick and wounded. The wheeled litter represented in Fig. 9 is provided with a frame of wood or light steel tubes and with rubber-tired wheels. With this litter a wounded man may be carried away with the utmost rapidity and with the least amount of injury from the jolting of the vehicle. Fig. 10, representing an interior view of a camp hospital, with its bath tub and shower bath, requires no extended explanation.—Illustrirte Zeitung.

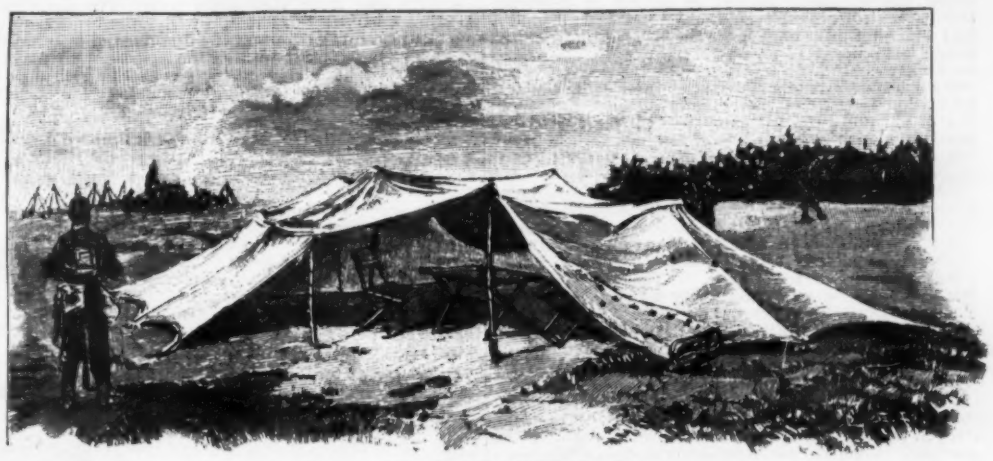


FIG. 6.—OFFICERS' SUMMER TENT.

FIG. 7.—STABLE TENT—INTERIOR.

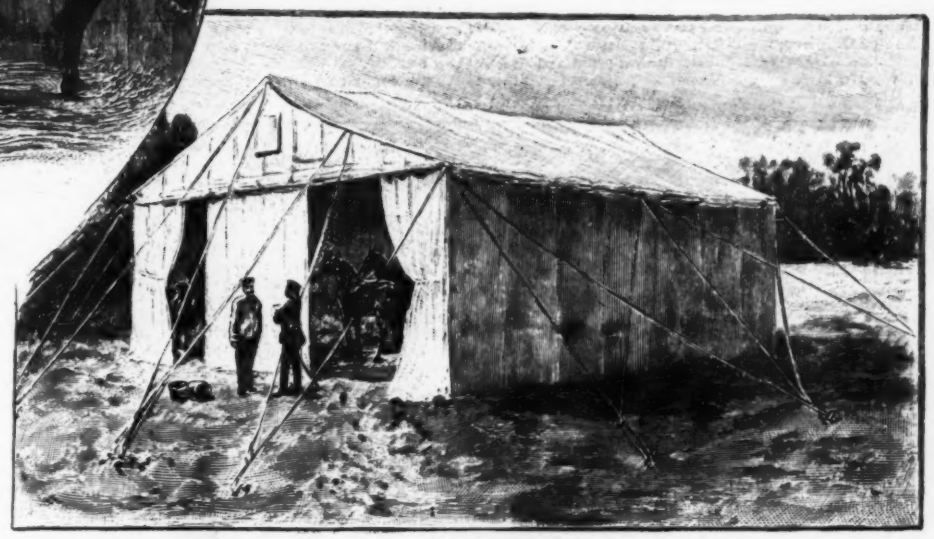


FIG. 8.—STABLE TENT—EXTERIOR.

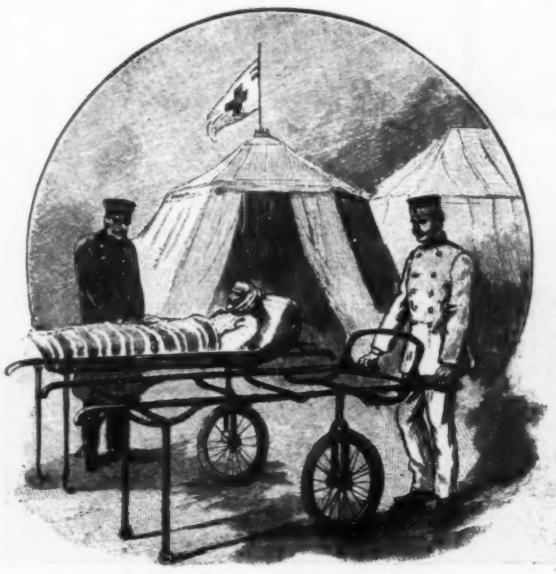


FIG. 9.—WHEELED LITTER.

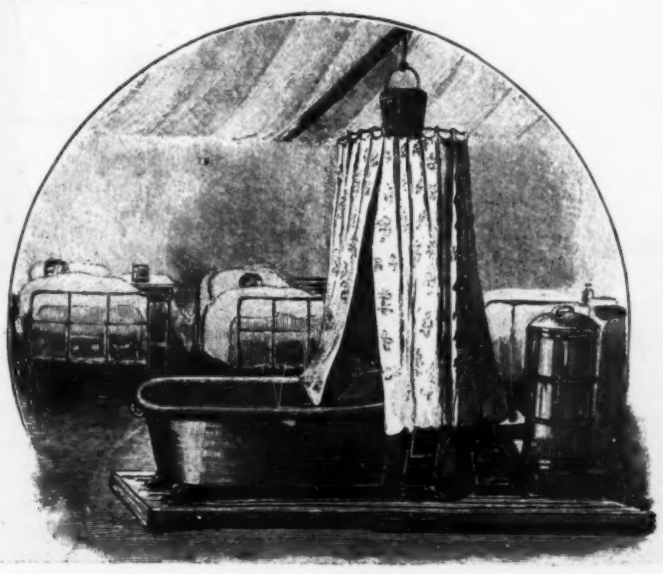


FIG. 10.—SHOWER BATH FOR A CAMP HOSPITAL.

Tempering Steel Wire.—To attain a uniform tempering of steel wire, the manner of annealing is of the greatest importance, and special care should be taken to see that all places are exposed to an equally high temperature. This is accomplished in a simple way by passing the steel wire through a lead bath heated to 700°–800° C., after it has previously been coated with whiting ground with water to keep off any oxide forming on the lead. In this manner the steel wire is uniformly heated throughout. According to whether it is desired hard like glass or elastic, the cooling is conducted in water or in oil. In case the chalk coating does not crack off by itself after the cooling, it can be readily rubbed off.—Deutsche Uhrmacher Zeitung.

THE BATTLE OF MANILA.

ON April 24 the governor of Hong-Kong, Sir Henry A. Blake, issued a neutrality proclamation, thus forcing the United States to begin its contemplated offensive movement against the Philippine Islands. Admiral Dewey sailed with the greater part of his fleet on April 24, and on May 1 the usual Spanish dispatches were sent out from Madrid stating that great enthusiasm was produced at that city over the publication of the contents of a private cable dispatch from Manila which told of what, according to the Spanish sender of the dispatch, was a glorious victory of the Spaniards over the American squadron that was sent to capture Manila. The people of Madrid were overjoyed to know that the boasted superiority of the American navy had been shown by the first engagement to be based on nothing but the usual braggadocio of the natives of the United States; but little by little it began to leak out that the bulletins were the usual mendacious ones with

which the Spaniards seemed to delight in deceiving themselves, for they deceived no one else; and soon it was known that Commodore Dewey's squadron had won a magnificent victory over the enemy, destroying nine war vessels, a transport and a water battery without the loss of a single American. The cable was cut by Commodore Dewey immediately after the fight, so that it was not until a week afterward that the official report of the great victory was received at the Navy Department. There were two dispatches, the first reading as follows:

"Manila, May 1.—Squadron arrived at Manila at daybreak this morning. Immediately engaged the enemy and destroyed the following Spanish vessels: "Reina Cristina," "Castilla," "Don Antonio de Ulloa," "Isla de Luzon," "Isla de Cuba," "General Lezo," "Marquis de Duero," "Cano," "Velasco," "Isla de Mindanao," a transport and water battery at Cavité. The squadron is uninjured, and only a few men are slightly wounded. Only means of telegraphing is to American consul at Hong-Kong. I shall communicate with him. DEWEY."

Following is the second message:

"Cavité, May 4.—I have taken possession of naval station at Cavité, on Philippine Islands. Have destroyed the fortifications at bay entrance, paroling the garrison. I control bay completely and can take city at any time. The squadron is in excellent health and spirits. Spanish loss not fully known, but very heavy. One hundred and fifty killed, including captain of "Reina Cristina." I am assisting in protecting Spanish sick and wounded; 250 sick and wounded in hospital within our lines. Much excitement at Manila. Will protect foreign residents. DEWEY."

By direction of the President, Secretary Long sent this dispatch to Commodore Dewey:

"Washington, May 7, 1898.

"Dewey, Manila.

"The President, in the name of the American people, thanks you and your officers and men for your splendid achievement and overwhelming victory. In recognition he has appointed you acting admiral, and will recommend a vote of thanks to you by Congress.

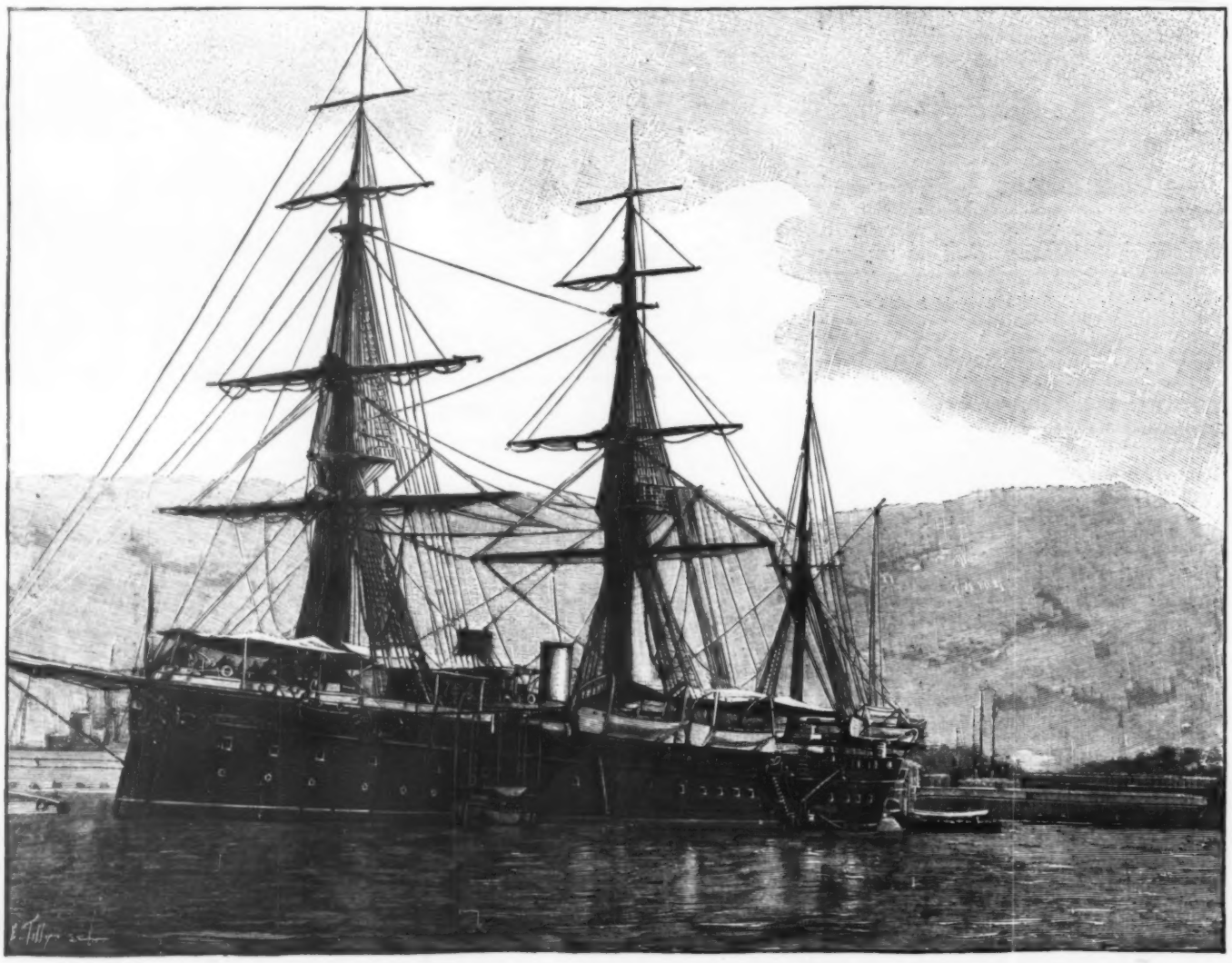
LONG."

Commodore Dewey arrived at Subig Bay, about thirty miles north of Manila Bay, on Saturday, April 30, and sent the "Baltimore" and the "Concord" to reconnoiter. He found no ships at the entrance to the bay, so the commodore decided to risk the mines, emulating the example of Farragut, and proceeded that same night at dark into the bay. The Spaniards had no patrol and no searchlights at the entrance of the bay. In fact, the Americans could probably have passed inside the bay without any challenge had it not been that some sparks flew up from the funnel of the revenue cutter "McCulloch," whereupon a few shots were exchanged with the batteries and Corregidor Island. The fleet did not slow down, and soon took up a position near the fortified arsenal of Cavité, and dawn was awaited.

As soon as it was light the two squadrons were seen opposing each other; the Spanish flagship, the "Reina Cristina," shown in our engraving, opened fire. Her action was followed by some of the largest Spanish warships and from the Cavité forts. The American squadron, led by the flagship "Olympia," did not reply at first, and the shells of the Spaniards did no harm, as they only struck the water, for it seemed to be impossible for a Spanish gunner to hit his target. A few mines were exploded, but did no damage. The American fleet drew nearer and nearer to the Spaniards in the following order: "Olympia," "Baltimore," "Raleigh," "Concord," "Boston," "Petrel" and "McCulloch." The Americans waited until they were within four thousand yards of the enemy, when the real battle began. The "Reina Cristina," the "Castilla," the "Don Antonio de Ulloa," the "Isla de Cuba," the "Isla de Luzon" and the "Mindanao" were in line of battle outside of Cavité and the gunboats and torpedo boats were inside the harbor.

The American ships passed back and forward six times across the front of the Spanish line, pouring in upon the latter a hail of shot and shell. Nearly every shot of the Americans seemed to tell, while every shot of the Spaniards went wide of the mark. After thoroughly demoralizing the Spanish fleet, Commodore Dewey then drew his vessels out of range before breakfast—something unheard of in naval warfare, which showed he knew he had absolute control over the situation and could destroy the city and fleet at his pleasure. The Spanish ships were in a terrible condition. The "Reina Cristina" was riddled with shot and one of her steam pipes had burst and she was soon set on fire. The "Castilla" began to burn, and they both eventually burned to the water's edge. The "Don Antonio de Ulloa" was frightfully torn by the American shells, and when her commander found she was sinking he nailed her colors to the mast and she sank

ADMIRAL MONTOJO.



THE BATTLE OF MANILA—THE SPANISH CRUISER "REINA CRISTINA," DESTROYED BY ADMIRAL DEWEY.

with all hands fighting to the last. Her hull was completely riddled and her upper deck was swept clean by the awful fire of the American guns. She continued working her guns on her lower deck until she sank beneath the waters. One shell from the "Olympia" raked the "Reina Cristina" throughout her whole length, causing her boiler to explode, killing her captain and sixty men. She then drifted away from the fire. Admiral Montojo transferred his flag to the "Castilla," which was sunk shortly afterward by a strong shot. After the American fleet ceased firing, which is variously stated to have been at 8 to 8:30, a conference of United States captains was held, and it was found that no one had been killed, but several had been slightly wounded by splinters. Two torpedo launches attacked the "Olympia," but she did not use her large guns, as the target was so small, but a hail of 6-pounder shells sunk the leading launch, all on board being killed; the other launch was beached with twelve shot holes, and the ship was covered with blood.

The battle was resumed about noon, when Commodore Dewey started to put the finishing touches to his early morning work. By 2 P. M. the "Petrel" and "Concord" had silenced the Cavité battery, leaving them a heap of ruins floating the white flag. The Spanish gunboats were then scuttled, the arsenal was on fire and the explosions of the Spanish magazine caused further mortality among the Spanish soldiers. No damage was done to the American vessels, except by one shot on the "Baltimore," which injured a half dozen of the crew by exploding some ammunition near one of her guns. Some estimates place the Spanish wounded during the engagement at over a thousand men and the number of men killed was very large; two hundred and fifty men were known to have been killed on board of two of the vessels. The forts at the entrance of the bay were dismantled, and Commodore Dewey announced that if any shots were fired at his fleet he would bombard the city. His fleet was then anchored off Cavité, and he is now waiting for the military force which is being sent him to reduce the islands.

Some of the incidents of the fight were very amusing. The "Petrel" chased a gunboat up the Pasig River, when the Spanish captain came in a boat to negotiate the conditions of surrender. The American captain said, "Unconditional surrender or fight." Upon this the naive Spaniard said, "We are willing to fight. Please allow us to send for ammunition, because our store is exhausted." It was almost a foregone conclusion that the Spanish would be worsted. At the time of the attack the Spaniards had no steam up, and it is said that the Spanish commander Admiral Montojo informed the governor-general that it was advisable to surrender in the interests of humanity, as it was impossible to resist successfully, but that he and his men were willing enough to fight and die; and even when his flagship was half shot away the commander, though wounded, refused to leave the bridge, though his ship was burning and sinking. Now it is stated that the authorities at Madrid are going to try this brave and unfortunate man, who was a victim of circumstances, for cowardice. This is the usual form of Spanish justice and reward.

Our engraving shows one of the best boats of the Spanish fleet. The "Reina Cristina" was the largest of the cruisers. She registered 3,520 tons, was 282 feet long; beam, 42 feet 7 inches; draught, 16 feet 5 inches. She was a single screw vessel built in 1886. Her engines had an indicated horse power of 3,970, and if her engines and boilers were run by competent persons, her speed was 17½ knots. She carried a complement of 375 men. The armament of the "Reina Cristina" consisted of six 6·2-inch Hontoria guns, two 2·7-inch guns, three 2·2-inch rapid-fire guns, two 1·5-inch guns, six 3-pounders, two machine guns and five torpedo tubes. She carried 160 officers and men.

Capt. Concha, commander of the Spanish cruiser "Don Juan de Austria," which was one of the fleet engaged with the ships of Admiral Dewey, said that the commanders of the Spanish ships realized that victory was hopeless in a fight with Dewey's ships, and fought only because of the strength of public opinion. He and the other commanders wished to steam out and meet the enemy, but Admiral Montojo forbade them to do so. The Spanish ships were in a disgraceful state. The engines of the "Don Antonio de Ulloa" were broken and the "Castilla" was leaking. The "Don Juan de Austria" had only two guns that could be fired and the "Marques del Duero" only one. We are indebted for our engravings to L'Illustration.

MACHINE FOR MAKING CARTRIDGES.

WE illustrate herewith, from La Nature, an ingenious machine for the manufacture of cartridges for fowling pieces. The apparatus, which is mounted upon a table and provided with a flywheel and transmission, consists of a disk, P (Fig. 1), which revolves around a central axis, and the circumference of which is furnished with recesses for the reception of the cartridges. These recesses are regulatable and capable of receiving different calibers. As soon as the apparatus is thrown into gear by means of the lever, R, each cartridge stops successively for an instant under the powder receptacle, A, the rammer, D, the shot receptacle, B, a second rammer, and finally under the setter, S E. Then it continues its route and reaches the piece, F (Fig. 2, No. 3), which applies itself to the head of the cartridge. As soon as the latter has stopped at the place desired, a spring, S, is freed and gives F the pressure necessary for the compression of the cardboard. At the same time, a lever, V, acts upon a bevel wheel, T, which transmits a rapid rotary motion to the rod that carries the piece, F, and the turning over of the edge is completed in a few instants.

The machine may be run by a motor of ¼ horse power only, and turn out 1,200 cartridges an hour; but, as a general thing, the power of one man fully suffices, since in actuating a pedal, without tiring himself, an operator can make 800 cartridges an hour.

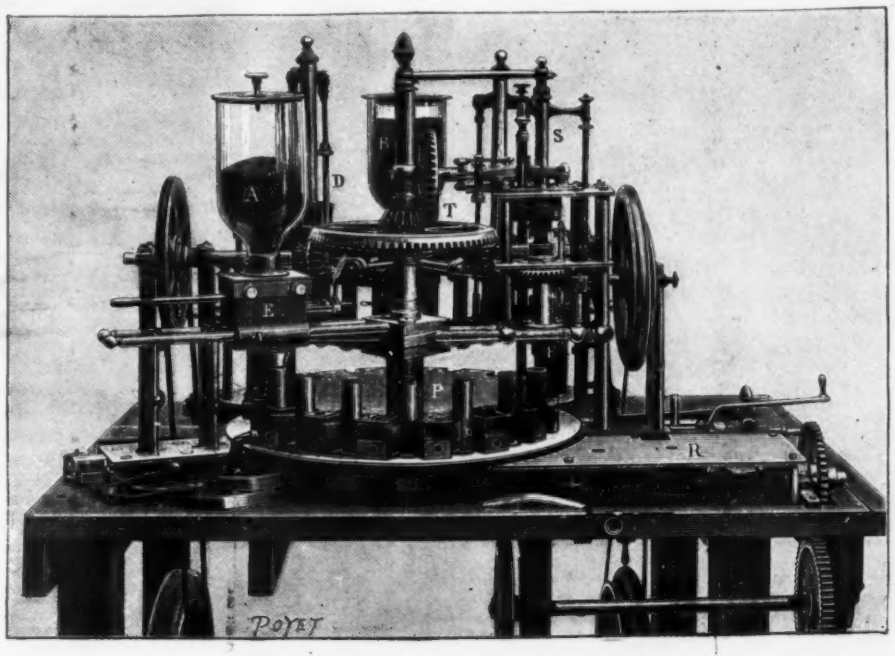


FIG. 1.—BELLAN'S CARTRIDGE MACHINE.

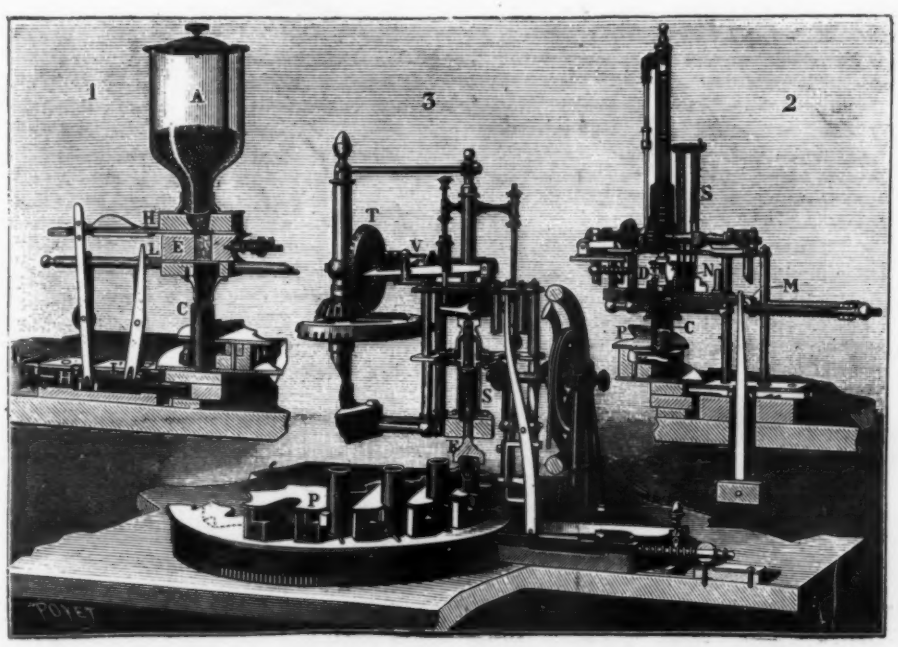


FIG. 2.—DETAILS OF THE CARTRIDGE MACHINE.

operator, who has only to remove and substitute an empty case for it.

The quantity of powder is proportioned by causing the capacity of the small cavity, E (Fig. 2, No. 1), to vary by means of a screw that make its sides recede from or approach each other. This cavity terminates in pieces, H and L, each of which is provided with an aperture, and is maneuvered by levers H′ and L′ in such a way that the piece, H, permits of the access of the powder while the piece, L, closes the lower part. Then, after the cartridge has reached the position, C, the two pieces move in an opposite direction, H closing the receptacle, A, while L gives passage to the proper quantity of powder, which falls into the cartridge case. This latter then passes under the rammer, S (Fig. 2, No. 2). A wad has already been brought into position by the spring, M, which has taken it from beneath the pile, N. The piece, D, mounted at the lower extremity of a rack, then enters the cartridge to the proper depth for obtaining a sufficient pressure.

The distribution of the lead is identical with that of the powder, and the second wad is placed in position by a mechanism similar to the one just mentioned. It remains to turn over the upper edge of the cartridge in order to keep everything in place To this effect, it is necessary to obtain a pressure and a rotary motion of

MINERAL WEALTH OF GREAT BRITAIN.

IT would be difficult to conceive of a more concise and clearly expounded compilation of statistics and general information regarding mines and mining than that presented in the third annual report upon the mineral industry of the United Kingdom of Great Britain and Ireland, which has been issued by the Home Office in the form of a blue book for the year 1896. The volume before us is a synoptical review of the condition of our own mineral industry, as well as that of other countries, which reflects unbounded credit upon its author, Dr. Le Neve Foster, and those who have assisted him in the work. It is divided into six parts, under the respective titles of persons employed, output, accidents, prosecutions, general remarks, and mineral statistics of the colonies and foreign countries. It contains, in addition, nineteen appendices, and concludes with an exhaustive index.

The statistics for the United Kingdom distinguish between mines or underground workings and quarries or open workings; and the same figures are marshaled again and again under different aspects, so as to show their varying significance when coalfield is compared with coalfield, inspection district with inspection district, and county with county.

The first four parts include sixty-nine tables, in which the various classes of information susceptible of being so dealt with are compared with each other and with the corresponding figures for the year 1895. These are followed by six diagrams, on which are shown by means of curves, extending from 1851 to 1896 inclusive, the yearly variations in the numbers of persons employed above and below ground; the output and export of coal; output, export, and import of iron ore; deaths due to accidents generally; deaths from accidents, arranged in five distinct classes (explosions, falls of ground, in shafts, miscellaneous and on surface); and the average quinquennial death rate per 1000 persons employed, classified in the same way as in the last case. In Part III. short descriptions are given of the circumstances under which the most important accidents of the year occurred; and throughout the volume many pertinent remarks are made, which serve to throw light upon the construction and meaning of the tables, point to the conclusions which they justify, and infer the lessons that are to be learned from their perusal.

Turning now to a consideration of the subject matter, we find that, taken altogether, there were 725,803 persons employed in or about mines during the year under review—576,325 working in the mines and 194,478, including 5,114 females, working on the surface. Of these numbers, 678,690 were employed at 3,260 coal mines, 16,819 at 136 iron mines and 30,294 at 720 other mines. In addition to this there were 112,829 persons employed at 7,758 quarries.

The quantity and value of the principal classes of minerals mined and quarried were as follows:

Name of mineral	Quantity	Value at the mines or quarries
	Tons	£
Clays	11,341,782	1,442,069
Coal	195,361,260	57,190,147
Iron ore	13,700,764	3,150,424
Limestone ...	11,011,350	1,215,604
Sandstone ...	4,507,745	1,417,985
Slates and slabs ...	586,933	1,338,256

The total value of all the minerals worked in the kingdom was £69,088,366, from which it will be seen that the value of the coal alone was practically five-sixths of the whole amount.

The number of separate accidents in mines was 886, involving the loss of 1,065 lives, of which 147 were the victims of four explosions of fire damp or coal dust. The number of separate accidents in quarries was 117, in which 124 lives were lost.

A comparative table showing the death rates from mining and quarrying accidents in different countries per 1000 persons employed brings out some remarkable facts. Taking the column which represents the total for underground and surface for the year 1896, or in the absence of the figures for 1896, those of 1895, we find the following rates for the coal mines in some of the principal coal-producing countries of the world:

Belgium	1·14
France (1895)	1·19
German Empire	3·57
Russia (1894)	1·29
United Kingdom	1·48
United States (1895):—	
Colorado	3·75
Illinois	1·94
Indiana	2·70
Indian Territory	1·64
Kentucky	1·02
Missouri	2·07
New Mexico	16·88
Ohio	2·11
Pennsylvania:—	
Anthracite	2·924
Bituminous	1·825
Utah	1·50

According to M. Louis Lacombe, who compared the death rates from accidents in mines in quinquennial periods, the last of which was 1890 to 1895, the ratios are as follows:

Russia 2·90, Belgium 2·38, England 2·18, France 1·37.

The death rate from accidents to railway servants in the United Kingdom for the year 1896 is given as 1·01 per 1000. The category includes such classes as carmen 0·47, clerks 0·17, mechanics 0·33, and signalmen 0·55, whose occupations are not by any means dangerous. On the other hand, the death rate among those who have to do with coupling and uncoupling and making up the trains is infinitely more serious, such as shunters 4·94, yardsmen 3·27, guards and brakesmen of goods trains 3·03. The highest of these figures pales before those applicable to sailing ships, among which we find:

British sailing ships (1896)	12·9
German " " (1893)	15·8

These figures prove conclusively that the miner's calling, when brought into comparison with some other kinds of employment, is not of such a dangerous nature as is generally supposed. As having a bearing upon this question, however, it may be stated that one of the most gratifying features of the report is the curve given on Plate 4, which shows the death rate per 1000 persons employed underground in coal mines to have been reduced from the appalling figure of 5·5 in 1851 to 1·62 in 1896. This result—upon the attainment of which the Home Office, the inspector of mines and the mining community generally may well be congratulated—is undoubtedly due to the efforts that have been made by means of legislation and inspection to remove the causes which formerly led to such a lamentable loss of life. The loss of 147 lives in four great explosions in the year 1896 is a black spot in the record which ought never to have been there. I am glad to observe that the year 1897 has been entirely free from anything of the same kind, and I feel confident that if the new regulations regarding the watering of dusty places and the use of explosives are attended to, or enforced with unflinching severity, we shall have seen the very last of such affronts to humanity and common sense.

The fines imposed upon owners and managers of mines for contraventions of the mines acts amounted to the insignificant sum of £258 13s. 9d., while the workmen for similar offenses paid £459 6s. 8d.

The outputs of coal from a few of the principal coal-producing countries were as follows:

			Metric tons
1895	Austria, brown coal		18,389,147
	" coal		9,722,679
1896	Belgium		21,252,370
1895	France, brown coal		437,000
	" coal		26,109,893
1896	German Empire, brown coal		26,797,880
	" " coal		85,639,861
1896	Great Britain		198,496,339
1895	Russia, anthracite		709,718
	" coal		8,369,420
1895	United States, anthracite		52,616,149
	" " coal		122,577,240

From these figures, with which I propose to bring this short and necessarily fragmentary notice to a close, it will be seen that this country still heads the list; but the United States are quickly overtaking us, and will, no doubt, come into the first position in the course of the next few years.—W. Galloway, in Nature.

SOME INTERESTING PLANTS.

THE Alocasia Wavriniana is a stately species from Celebes, and differing from any other known to us in cultivation or in the herbarium. The leaves form a dense, erect tuft, each leaf stalked, lanceolate, glabrous, deep blackish green-gray on the under surface. Petiole purplish, spotted with pale green, 15 inches long, of the thickness of the thumb, much dilated at the base, above channeled and deeply winged; blade about 20 inches long, 6 inches wide, lanceolate acuminate, truncate at the base, deeply pinnately lobed, lobes bold, rounded, pointing toward the apex of the leaf; midrib prominent on both surfaces, secondary veins remote, coming off at an acute angle and terminating in the marginal lobes; tertiary veins crowded, inconspicuous. The species is a native of Celebes and was introduced to the Sanderian nursery by Mr. Micholitz. It has been named in compliment to the Comte de Wavrin.

The Furcræa Watsoniana is a beautiful and striking species, with leaves in tufts, each leaf spreading, as long as the arm, 2½ inches wide, convolute when young, undulate at the margin, and provided at distant intervals with minute spines. The disk of the leaf is bluish-green, with alternate bands of cream-colored variegation.

The Ptychosperma (?) Warleti is a palm with silvery-gray stem more or less thickly covered with coarse blackish or purplish hairs. The foliage is pinnate, the segments oblong cuneate, rose at the margins and sli

ALOCASIA WAVRINIANA: MAST. EX. HORT. SANDER. LEAVES BRONZY-GREEN, MUCH REDUCED.

FURCRÆA WATSONIANA: HORT. SANDER. CREAM-COLORED VARIEGATION, MUCH REDUCED.

PTYCHOSPERMA (?) WARLETI: HORT. SANDER.

very beneath. We do not give the dimensions, as the plant is still young and likely to develop in size and form as growth goes on. In the meantime it is very distinct and highly decorative in character.—The Gardeners' Chronicle.

STRAWBERRY LEAF SPOT.

THE strawberry leaf spot (Sphærella Fragariæ, Tul.) is a very destructive and widespread disease, occurring wherever the strawberry is cultivated; it is also met with on the leaves of wild strawberries, and from thence probably often passes on to the cultivated varieties. The leaves are the parts attacked by the fungus, the earliest sign of its presence being indicated by the appearance of scattered minute dark-red spots on the upper surface of the leaf. These spots as a rule rapidly increase in number, and also in size, adjoining spots often growing into each other, and forming larger, irregularly shaped blotches. As the spots increase in size, the central portion of each becomes gray or whitish, and is surrounded by a narrow dark-red ring. When the fungus has reached this stage of development, examination with a pocket lens shows the pale central portion of the spot to be sprinkled with very minute white tufts. Each of these tufts is composed of a bundle of very delicate white threads, or hyphæ, each of which bears an exceedingly minute reproductive body, or conidium, at its tip. When quite ripe the conidia become free, and are then carried by wind, rain, insects, or very frequently by watering or spraying, on to other strawberry leaves, where, if the surface of this leaf is damp with dew or rain, they germinate at once, enter the tissues of the leaf, and soon give origin to a new disease spot. As the conidia are produced in immense numbers and in rapid succession, the disease spreads very quickly in the case of plants growing near to each other, unless preventive measures are adopted.

This conidial condition of the disease, which continues in vigorous growth throughout the season, was at one time considered to be an independent fungus, called Ramularia Tulasnei. Toward the end of the season, numerous very minute black raised points appear on the diseased leaves; these represent the second form of fruit produced by the fungus, each point being a fruit of complex structure, containing in its interior numerous spores or germinating bodies. These spores remain in an unchanged condition till the following spring, when they germinate and inoculate the young strawberry leaves, giving origin to the first or conidial form of the fungus. Another form of reproduction, which, like the spores, also serves to tide the fungus over the winter season, consists of minute black aggregations of the mycelium of the fungus called sclerotia, which are formed in the tissues of the decaying leaves. These also remain on the ground unchanged until the succeeding spring, when they produce a crop of conidia, some of which find their way on to the surface of the young strawberry leaves and commence the disease afresh.

If the leaves of the strawberry are badly diseased, a good crop of fruit cannot be properly matured; furthermore, plants that have been seriously attacked by the disease, especially if the second crop of leaves, which appear after the fruiting season, is injured, afterward remain weak, and as a rule are not worth preserving. Repeated experiments, both in this country and in the United States, have clearly proved that the disease can be held in check by the use of Bordeaux mixture. The plants should be sprayed with a dilute solution when the leaves are beginning to expand, and again at intervals if the fungus shows itself. It is most important that the plants should be sprayed after the fruit is gathered, so as to protect the second crop of leaves, as the vigor of the plants, and consequently the quantity and quality of fruit produced in the following season, depends to a very great extent on the amount of material accumulated by these leaves.

All diseased and dead leaves should be raked together and burned, so as to guard against infection the following spring; for although the leaves, if allowed to remain on the ground, would probably decay and disappear during the winter, yet the fungus fruit and sclerotia present in their tissues would not decay, but remain on the ground, and germinate in the spring, when some of the conidia produced would almost certainly find their way on to the surface of the young leaves, and thus commence the disease.—G. Massee, in Gardeners' Magazine.

DISEASED STRAWBERRY LEAF.

1. A diseased strawberry leaf; natural size. 2. One of the minute white tufts of the first, or conidial form of fruit; × 400. 3. One of the minute black raised points forming the second, or ascigerous form of fruit; × 100. 4. A large cell or ascus, containing eight spores in its interior. Many of these asci are produced in the interior of an ascigerous fruit; × 400.

PESTS AND POISONOUS CREATURES PECULIAR TO CUBA AND THE PHILIPPINES.

By Dr. G. ARCHIE STOCKWELL, F.Z.S.

THE mosquito is omnipresent, but exhibits the extremes of virulence on the shores of the Arctic Ocean and in the tropics. Not content with removing a portion of her victim's blood, for it is the female that is always the offender, she delights to replace with a poison that leads to itching, swelling and perhaps even more violent inflammation.

Closely allied to the mosquito, but much more vicious and virulent, is the gnat of the tropics, against the onslaughts of which, mosquito netting is no barrier.

Even a greater pest is the minute tropical sandfly, for it is still more difficult to cope with and more venomous than either of the foregoing. Like the gnat or mosquito, this pest is most abundant near the water, but, unlike the other two, it does not haunt marshy districts and damp herbage, but rather sandy and ridgy ground.

So-called "horse flies" or "deer flies" will attack man, sometimes most viciously; and in the tropics especially they are also the torture of all four-footed kind that are not efficiently protected by natural clothing or artificial methods. All are bloodsuckers; still worse, they delight to deposit their larvæ beneath the skin along the spine of horses, mules, etc., where the integument is thinnest, and one species also deposits its eggs in the nose of these creatures. The bite of the horse fly is quite painful, and will induce swelling and inflammation that may last for days; it can even induce blood poisoning. A favorite spot of attack, as regards man, is the back of the neck; but so expert is it at venesection, that it is not until its body is gorged with blood that its presence is suspected.

Another plague is an exceedingly small insect, belonging to the class known as Mites. It is, in fact, so minute as to escape observation unless the eye is brought close to it. Its favorite lurking places are among the grass and upon minor shrubs. It has a variety of local names, notably "diablito colorado," though in the French West Indies, because of its bright scarlet hue, it is known as bête rouge. It abounds during the rainy season, and its bite causes intolerable itching, which, as Schomburg expressed it, "by day drives the perspiration from every pore, and at night makes one's hammock resemble the gridiron on which St. Lawrence was roasted." Nevertheless, the bites must not, on any account, be scratched, since, if the skin is once broken or abraded, a most ugly sore is apt to result that will be very difficult to heal.

Blood-sucking ticks are another annoyance of tropical regions. They bury the whole head in the flesh, and distend their bodies with blood ere they are discovered, and any ordinary attempt at removal only detaches the latter, leaving the head behind to create trouble. The head should be removed with needle or knife, and the wound subsequently dressed antiseptically. The most bloodthirsty form is termed garapata.

There is likewise a species of ant (hormigas) that lives in considerable colonies, chiefly in and about the sugar cane fields, being very destructive to the canes; but it does not hesitate to attack the man who camps on or near its preserves, when it becomes more obnoxious than the ticks or even the bête rouge. This vivigagua, as it is called, bites with exceeding fierceness, producing the impression that one has been pierced by a red hot needle. Luckily, it is by no means generally distributed, and seldom takes the offensive save in the rainy season. Unfortunately, there is no protection to be had from its onslaughts or those of the ticks and diablito colorado, except carefully burning over the ground before camping, or using a liberal sprinkling of insect powder, or of poke root and borax mixed. But a certain amount of immunity may be had against ants and ticks, as well as centipedes, scorpions, spiders and venomous reptiles, by wearing tight, close-woven canvas leggings or high-topped boots.

Another insect, one that closely resembles the common flea, and that in Cuba and Puerto Rico demands to be specially guarded against, is the nigua, chigoe or "jigger." It is the female only that is annoying, and she is especially apt to work her way beneath the skin at the ankles, or preferably at some part of the foot, most often between the toe nail and the flesh, but sometimes between the toes. Having buried herself, an intolerable itching results, at first rather agreeable than otherwise, but after a few hours becoming intolerable and merging into most violent pain; at the same time a small white, bladderlike tumor develops under the skin, about the size of a pea, with a dark spot in the center. The tumor is the rapid-growing nest, developed from the posterior portion of the body of the chigoe, and the black spot the anterior portion of the little pest. And now it is full time to think of getting rid of the incumbrance, an operation in which negro women generally are very expert. With a fine needle they remove the skin from the little ball or nest, precisely as one would peel an orange, and then, making pressure with the thumbs, succeed in squeezing out the sac of eggs; the cavity is then filled with snuff or tobacco to guard against the possibility of development of any ova that may accidentally have escaped from the sac and been left behind. The unacclimated and new comers are especially subject to the attacks of the chigoe. Violent inflammation and even mortification and gangrene have resulted from neglected chigoe sores.

Scorpions are peculiar to the tropics and subtropics the world over, and equally abundant in the Philippines, Canaries, Puerto Rico and Cuba. They for the most part hide under stones, fallen tree trunks, in the roof thatch and dark corners of deserted huts, and obscure parts of inhabited dwellings; likewise they have an unpleasant way of taking possession, overnight, of one's boots, stockings or trousers. Their weapon is in the tail, and it is used by bringing the latter forward over the back and head; but the creature first endeavors to lay hold of the object it desires to sting with its claw or lobster like pincers, presumably to obtain better leverage for his weapon, or to prevent the escape of the foe. Despite the tales of travelers, scorpion stings, though painful, are not usually dangerous to persons in good health, and are generally easily relieved by camphor, rum, lemon juice, ammonia or solution of carbolic acid, though considerable inflammation and swelling may be produced, and even persist for a couple of days, along with slight fever. It is only in rare instances these symptoms present any marked degree of severity. The American forms of scorpion are much less virulent than their European, African and Asiatic brethren.

The centipede is another bugbear, and is had in the tropics of all sizes from one inch to six inches in length, and a diameter of less than a quarter of an inch to the size of one's thumb; but it is no more dangerous than the scorpion—which it resembles as regards habits—except as it is made an excuse for swallowing large quantities of alcohol. Its weapons are its jaws; and it, too, has an unpleasant way of taking possession of loose wearing gear. The remedies used for the sting of the scorpion are equally effective here.

Spiders of infinite variety of sizes, color and habits are numerous in the tropics. Though the majority are not to be classed as poisonous, their bites seem especially prone to develop the fevers of the region, or to provoke ulcerations that are healed only with the greatest difficulty. The ground and trapdoor spiders grow to great size; often the body alone is 2 or 2½ inches in length. They are hairy, most repulsive creatures, living in wells or tubes excavated in the soil, with a trapdoor atop which is closed when the tenant is at home. The common trapdoor spider is generally known as "tarantula" in Jamaica, Puerto Rico and Cuba, because of its close resemblance (but generally of smaller size) to the true tarantula, which is also found, but more sparingly. Both will inflict unpleasant wounds when opportunity offers, but these are not of the highly poisonous and dangerous nature generally imagined. No death has ever been recorded as the direct result of a bite of either the tarantula or centipede, or sting of the scorpion. The writer has suffered from all three, and never witnessed any more untoward result than an ephemeral fever, and he would infinitely prefer such to the onslaughts of myriads of mosquitoes, ants, gnats, or the tortures inflicted by the bête rouge.

There is but one virulent serpent in Cuba and Puerto Rico, but there are two in the Philippines. That of the former islands, known as boaquira, or juba (pronounced huba), is never more than 4 or 5 feet long, and practically, if not specifically, is identical with the rattlesnake of Florida; fortunately, it can generally be recognized by its mode of coiling when about to assume the offensive and the warning it always gives before striking. The claim that venomous serpents can always be detected by their broad, flat, lanceolate heads is by no means to be depended upon; but they usually exhibit an aperture or slit on each cheek behind the nostrils and an elongate, vertical pupil like many other nocturnal creatures—for venomous snakes are generally nocturnal or crepuscular, or both, and when met abroad in the day time their presence is due to accident; again, no venomous serpent will ever be found in or on a tree, and most have clubbed instead of slender tails; and rattlesnakes prefer, as a rule, the more dry, elevated and stony districts. When other evidence is lacking as to the character of the reptile, it may be pinned to the ground by means of a short-forked stick pressed upon the neck immediately behind the head, when the mouth can be pried open and examined for poison fangs. Commonly under such circumstances the fangs will be seen hanging perpendicularly from either side of the forepart of the upper jaw, or they may be directed forward in a horizontal plane, just projecting beneath the upper lip—the position for wounding or striking. Besides, if the creature

is enraged, minute drops of mixed venom and saliva will be seen exuding and dripping from the fangs. If the serpent is quiescent, these fangs are retracted until they lie horizontally along the upper jaw with their points looking backward. Though rattlesnakes are dangerous, more so in warm than in more temperate regions, the wounds they inflict are not so universally fatal as popular prejudice would lead people to believe. Were this not so, there would never have been exploited the number of nostrums that on various occasions have received credit as being "perfect antidotes" and "sure cures."

It has just been remarked that rattlesnakes are by no means so venomous as generally imagined. This is dependent on two causes, viz., season and habits of life. Their extreme virulence is developed during the hot season or the period of reproduction. But venomous snakes, with few exceptions, are sluggish, and the poison they possess is given them as a means of securing prey. This poison consequently is a powerful paralyzant, and the creature bitten cannot get far away from his would-be devourer. Once a creature is bitten, the major portion of the poison contained in the sacs at the base of the fangs is used up, and it requires hours to reproduce in any quantity. The second use of the fangs, consequently, does not develop the virulence that the first does; and the third is still less venomous, and perhaps not at all so, the fluid exuded by the fangs being merely a secretion analogous to that developed in the salivary glands of man. Space will not permit an elaborate description of the mechanism of the poison apparatus, but to those who desire, such will be found in the SCIENTIFIC AMERICAN SUPPLEMENT, Nos. 421 and 1029; but this much may be said in the way of warning, viz., that even after the fangs are removed the creature sometimes develops a new pair with surprising rapidity, the only safeguard being to destroy the bulb at the root of each of these tiny weapons; also that the vipers of the far East are more abundantly supplied with venom than the rattlesnakes and are more virulent and the fangs more quickly renewed.

There is also found in Cuba and Puerto Rico a form of boa constrictor termed by naturalists the "dog-headed tree boa," and known to the natives as the maja (pronounced mahya), which scarcely ever exceeds 7 to 10 feet in length. It is harmless as regards man, save if cornered, when it certainly will fight, and because of the peculiar hooked character of its teeth inflicts fierce, ugly, deep and ragged bites that may, though the creature is in no sense venomous, provoke bad ulcers difficult to heal, or even lead to blood poisoning.

Every creature so far mentioned has its representative in the Philippine Islands, which have in addition a bloodthirsty land leech, most tormenting but not dangerous, and whose attacks in certain districts are not to be avoided except by the use of stout, specially woven leggings. Countless hosts of these infest rising grounds contiguous to certain low-lying dark jungles. They are about an inch in length, of the diameter of a fine knitting needle, but capable of distension until they have doubled their length and attained the diameter of a goosequill; and their structure is so flexible that they not only insinuate themselves through the meshes of a fine silk stocking, seizing on the feet and ankles, but ascend to the back and throat and fasten on the most tender parts of the body; the scrotum, inside of thighs and contiguous parts, are favorite spots for attack. The whites are obliged to protect themselves by means of "leech gaiters," the cloth being woven so closely as to be absolutely impermeable. The creature, when on the lookout for prey, plants one extremity on the earth, raising the other perpendicularly to look out for victims, and such is their vigilance and instinct that on the approach of man, horse or buffalo they may be seen among the fallen leaves and grass, even on the stalks of the latter, close to the edge of the path, poised erect, waiting to attach themselves. And now their peculiar mode of progression may be noted, which is by semicircular strides, so to speak, by advancing one extremity, arching the body and bringing the other extremity forward, till by successive advances they are able to lay hold of the victim. If man, the clothing is ascended in search of some point for entrance; and if there is a party, those in the rear ranks are always the greatest sufferers, for the little creatures gather with wondrous celerity, being guided, apparently, more by the vibration produced on the ground than any phenomenal range of vision. Their size is so insignificant and the wounds so skillfully inflicted that their presence is usually unsuspected until the victim is warned by the trickling of blood or by the cold, clammy touch of the gorged leech pressing upon the skin. In those of robust health, leech bites amount to little beyond mere annoyance, the difficulty sometimes encountered in stopping the bleeding, and slight, inflammation and itching like that experienced from mosquito bites; but in those of degraded habits, with the germs of tropical fever in their blood, the punctures, if rubbed or scratched, are liable to degenerate into ulcers that may lead to loss of limb or life. In 1815, during the Randyan rebellion in Ceylon, the white soldiers and Madras sepoys suffered so severely from land leeches that great numbers perished. Horses and cattle are made wild by them, and stamp the ground with fury to shake them from their fetlocks, to which they hang in bloody tassels.

Two venomous reptiles inhabit the Philippines, besides a form of boa which can hardly be deemed dangerous—one of the first named, fortunately, somewhat rare. This latter in the Tagloc tongue is termed alinmorani, and frequently attains a length of 8 to 10 feet, and, unlike poisonous reptiles as a class—there are but three or four exceptions—is apt to take the offensive and attack man. One should never flee from it, since then his fate is sealed, but, facing the reptile, attack it with a stick or club; and, fortunately, it is easily dispatched by a slight blow on the neck. The other is a small viper, allied to the tic palunga (or Rusell's viper) of India, Ceylon, Sumatra, Java, the Malay Peninsula, etc., called dajon-palay by the natives, hoja de arroz by the Spaniards—literally "rice leaf." It is for the most part nocturnal in habit, and during the day lies coiled up in some nook beneath thick herbage. It is well to examine boots and clothing for its presence before donning the same in the morning. This viper may be recognized by its club-shaped or obtusely pointed tail.

Ticks, fleas, gnats, mosquitoes and like small pests, including spiders, scorpions and centipedes, abound, but do not vary materially from their West Indian relatives.

Mention may likewise be made here of an exceedingly poisonous growth, fortunately very rare in Cuba, a tree belonging to the family of Dogbanes, known as guamacha, and one of the sources of the negro poison known as "Obeah water." So virulent is the wood, that, when used as spits for the roasting of meat, the latter is so imbued with poison as to fatally affect those who partake of it. Five pounds of the wood will, in twenty-four hours, poison a tank holding twenty tons of water; and, unfortunately, there is no method known to science as yet whereby the poison can be detected in fluids.

Treatment.—Undoubtedly the most effective protection against venomous insects, mosquitoes, gnats, sand flies, deer flies, etc., is an ointment made by mixing equal parts of oil of tar with some fat, such as vaseline or hog's lard, but the application demands to be renewed at least once an hour. Ointments of carbolic acid, oil of pennyroyal, etc., though fairly effective in temperate regions, are too volatile to be used with success in the tropics. The very fat base of an ointment, as well as the heat of the skin, seems to favor volatility. Carbolic acid in watery solution, if it does not come in direct contact with the skin, i. e., on hairy parts, is more successful, especially as regards deer or horse flies. Horses and mules may be protected from their attacks by sponging thoroughly, every three or four hours, with a solution made by adding one or two tablespoonfuls of acid to a stable bucketful of water. Lemon and lime juice tend to reduce the pain and swelling induced by the bites; also powdered ipecac made into paste with water and applied. Where flies deposit their larvæ in the nose of an animal, a douche or solution of corrosive sublimate, 1 to 1,000 or 3,000 (or potassium permanganate, 1 to 500), is usually very effective and should be followed by daily insufflation of calomel. The same treatment applies to man when insects of smaller variety, as they sometimes do, deposit larvæ in the nasal passages; also chloroform inhalations or spray are valuable and sometimes the only effective remedy. When larvæ are deposited in the back of a horse or mule, the sac demands to be freely opened, and packed with an antiseptic such as iodoform and boracic acid, equal parts.

Despite idle tales regarding scorpion stings, the swelling and inflammation is usually allayed by camphor, rum, lemon juice, carbolic acid, ipecac poultice, or a liniment made by mixing equal parts of ordinary ammonia water, olive oil and laudanum. Also a few drops of ammonia water or the aromatic ammonia spirit, diluted, may be given internally if demanded.

The intolerable itching caused by the bête rouge is best relieved by rubbing the bitten spot with strong lime or lemon juice, rum, alcohol, saturated solution of camphor in spirit, or carbolic acid of medium strength. Tincture of echinacea and oil of lobelia have been recommended on theoretical grounds, but the evidence thus far adduced must be considered as insufficient.

As a matter of fact, there is not and cannot be any such thing as an antidote to serpent venom; it is a physiological impossibility. The only thing that can be done is to throw a ligature—a tightly tied and twisted cord or handkerchief—about the bitten limb and above the wound, foster free bleeding therefrom and as soon as possible seek the services of a medical man. As the poison exerts its chief effect upon the brain and nervous centers, as evinced by drowsiness, stupor and failure of heart and respiration, every effort should be made to combat the two former and sustain the two latter, which is best done by violent exercise, which should be enforced at the point of the stick, if all else fails. The real secret of the phenomena developed, as above, and also including the swelling and discoloration of the parts, is the poison destroys the blood corpuscles with which it comes in contact. These corpuscles agglutinate and some cling to the walls of the smaller blood vessels, producing the swelling and discoloration, while others in agglutinated form are returned to the heart, carrying more or less disintegration to other corpuscles with which they come in contact, and when sent to the lungs they are unable to take up any of the oxygen there provided by the respiratory act, but are returned to the heart and sent back again through the circulation, a large proportion going to the brain and clogging its minute blood vessels, interfering with function and provoking paralysis. Violent exercise not only sustains the heart and respiration but opens the ducts and pores of the skin, stimulates the kidneys and lungs, and thus tends to get rid of the poisoned and effete matters in the circulation by the process of excretion, which is thus greatly hastened. Alcohol, strychnine and other stimulants, except given by a medical man to stimulate and sustain a flagging heart and circulation (and their use demands great circumspection and their action to be carefully and steadily watched), are often more detrimental than otherwise. The powerful nature of the serpent venom and its effect upon the circulation can be surmised from the fact that those poisoned thereby develop most fetid exhalations of the body and breath; the blood loses its power of absorbing oxygen and of coagulation; the mucous membranes, particularly of nose and mouth, become spongy and bleed on the least provocation, and the hemorrhage, though seemingly of natural hue, gives scarcely any stain or color to a handkerchief or other white cloth, all evidencing the great destruction that has been wrought among the vital constituents of the circulation.

Discussion of treatment by "antivenin," so called, or by the serum method, would here be unprofitable, since such demands the judgment and intervention of a medical man.

New York City.

The complicated piece of track elevation work at the Sixteenth Street crossing in Chicago is now under way, and the foundations of some of the abutments of the overhead bridges are being laid. All street car traffic in Clark Street north of this point has been abandoned. The Halsted Street, Center Avenue and Wallace Street, and Wentworth Avenue cars of the Chicago City Railway will reach the downtown district by way of the Archer Avenue electric line and the State Street cable line. The street car traffic in State Street will be very congested for several weeks.

THE DEVELOPMENT OF THE CENTRAL STATION.

By SAMUEL INSULL.*

MR. PRESIDENT AND GENTLEMEN: When requested a short time ago by the chief of the electrical department of this University to deliver a lecture on some subject connected with central station work, I must confess to having had some misgivings in accepting the honor to appear before you this evening, remembering the disadvantages that a commercial man invariably feels in discussing technical matters before those having had technical training; but then I remembered that even within my own time (and I think I can still claim to be a young man) very little was known of the general distribution of electrical energy from a central station, and when I recalled that so recently as the early 80's it was necessarily the rule for "guessing to be a substitute for mathematics" (to use the words of the great pioneer in central station work), my misgivings were inclined to disappear, and I felt encouraged to talk to you on the development of the central station from the point of view of my own experience in following this, the latest of the great industrial developments of the wonderful era in which we live.

In referring to the development of the central station, it would seem hardly necessary to go at length into the history of the business, the origin of which probably dates from the work of the early experimenters, whose efforts were directed to the perfection of series arc lighting. While their work is entitled to the greatest possible praise, it should be remembered that the theory on which they worked, namely, constant current and varying potential, is a theory foredoomed to failure when applied to the development of a system of general distribution for light and power purposes, the first essential of which is the necessity for a constant potential, the quantity of current varying in accordance with the demands made by those desiring to use the energy, whether for light or power purposes. Nor does it seem to me a matter very pertinent to the present occasion to trace the rival claims as to priority of invention of the early experimenters on incandescent lamps. Which of them was the first to produce a lamp that could be brought to a state of incandescence by means of the electric current is hardly within the scope of our inquiry. Probably all of them, groping in the dark (now and then illumined by the flashes of light emitted from their experimental glow lamps), contributed in a more or less degree to the perfection of the incandescent lamp as now in everyday use; but so far as their contributing much that is substantial in the development of a system of central station distribution, it is probable that, up to the year 1880, there was but one man who realized that in solving the great problem of electrical distribution the perfection of a filament of high resistance, which placed in a hermetically sealed glass globe from which the air had been exhausted and connected in multiple arc across an electric circuit, was the first necessity to the distribution of electric energy in our cities from a central station system.

In Mr. Edison's application for a United States patent on a system of electrical distribution filed at Washington on February 5, 1880, he says:

"The translating devices for each house may be either for light or power or both. For light, the electric lamp consisting of an incandescing material hermetically sealed in glass (shown in other applications made by me) is preferred. This lamp is made of a high resistance in comparison with that of any electric lamps which, to my knowledge, have been proposed. In lights heretofore proposed the endeavor seems to have been to lessen the resistance of the carbon, none having been suggested of higher resistance than, say, 10 ohms; but I have discovered that a very much higher resistance, say 100 ohms, must be used in order that a number may be economically and successfully used in a system."

The question of the high resistance of the translating device was the first stepping stone to success. Everybody prior to Edison had aimed at getting a low resistance lamp, I presume on the theory that the less the resistance of one, the less the resistance of the whole series. He struck out on new lines. A high resistance lamp was naturally followed by a multiple arc system.

In writing of the necessity of a high resistance lamp, the applicant for the patent had in mind that a system of electrical distribution could be used at the same time not only for lighting, but for power purposes, if the motors were properly constructed, and this is evidenced by the next paragraph in his application, which states:

"The motors should be so constructed that each, with a constant flow or pressure of current, will give the exact power required. This requires that each motor should be wound with finer or coarser wire, and into more or less convolutions, which determine the maximum effect of the motor."

If you will search the files of the daily and technical journals and the proceedings of various scientific societies on both sides of the Atlantic from the summer of 1878 up to and including the year 1882, you will find that the great obstacles in the way of an economical system of central station distribution were the difficulties of producing a lamp that would last, one requiring only a minimum of current, and a system of electrical distribution requiring a minimum of capital, so as to enable electricity to compete with then existing methods of illumination and power. Prof. Henry Morton, on December 28, 1879, says in the New York Times:

"The first difficulty of all is the production of a lamp which shall be thoroughly reliable and neither complicated nor expensive. All attempts up to the present lamp in this direction are acknowledged to be failures, and, as I have pointed out, there does not seem to be any novelty such as would authorize us to hope for better success than the present one. The next difficulty is the economical production of small lights by electricity. This is what is commonly meant by the phrase 'dividing the electric light.' Up to the present time, and including Mr. Edison's latest experiments,

* Before the Electrical Engineering Department of Purdue University, Lafayette, Ind., May 17, 1898.

it appears that this involves an immense loss of efficiency.

"Next comes the difficulty of distributing on any large scale the immense electric current which would be needed and to provide for their equal action at different points under varying conditions of the number of lights used."

Again, Mr. Conrad Cooke, giving evidence before the British Parliamentary Commission in 1879, in answer to the question, "Supposing that the occupier of one house wished to put out his lights, how would this be effected?" replied:

"In that case, if you throw out a lamp or throw out a house, you must throw into the circuit a resistance exactly equal to what you cut out. If you do not do that, you will affect every lamp in the series and the machine as well. If you put out your lights by breaking the circuit, you put out every light in the series."

In answer to another question at the same Parliamentary inquiry, Mr. Cooke said (referring to Dr. Siemens, who had been named in the question):

"His nephew told me himself that he had seen, I think, over two hundred lamps on one of Edison's circuits."

And Mr. Cooke added:

"I must say I should like to see it myself, and that is all I can say."

It is quite evident from this that Conrad Cooke, very well known in England as a prolific writer on the subject of electrical experiments, had in mind in 1879 nothing better than the series system, that is, a number of incandescent lamps run precisely the same as arc lamps, or, to put it another way, his idea of the electric lighting system was a varying potential and a constant current, which could never be run on a large scale successfully. Sir William Thomson (Lord Kelvin), referring to the same Parliamentary inquiry of 1879, says:

"I had not myself at that time any idea leading toward the practical realization of any such distribution of conductors and placing the lights as outlined in the Edison multiple arc and feeder system."

Evidently Mr. Swan, the English inventor, had no idea of the feeder system as late as October, 1880, as in a lecture before the Literary and Philosophical Society of Newcastle, England, at that time, he said:

"The only way of avoiding this waste of energy, without abandoning the idea of small units of light, would be either to employ enormously thick conductors or have a very limited area supplied from one source."

Mr. Swan was referring to Mr. Edison's plain multiple arc system, as set forth in his application of February, 1880. The last eight words of this quotation prove that Mr. Swan did not then know of Mr. Edison's feeder system, application for patent on which was made on the 9th of August, 1880, and was patented in England on the 24th of September of the same year. It would seem that in 1882 Mr. Swan, who himself at that time must have been informed as to Mr. Edison's invention of the feeder system, could not have appreciated the possibilities of such a system, as, in a paper communicated to the British Association, at Southhampton, in August of that year, he stated:

"The only escape from that limitation (extent of distribution) lay in having secondary batteries at stations or in houses, and in these batteries being connected in series and fed by currents of higher tension, the principle still holding of multiple arc, not from the central station, but from the subsidiary ones from which the batteries are charged. Once imagine the possibility of these secondary batteries being kept at a perfectly constant condition of charge by some automatic arrangement, and we might look to that as a means of escaping from the difficulties of wide distribution."

Again we find that Dr. C. W. Siemens, before the Society of Arts, in London, on the 15th of November, 1882, said that he thought:

"It would be possible to establish electrical mains in the shape of copper rods of great thickness, with branches diverging from them in all directions, though he was himself decidedly averse to such a plan. He said he would limit the area of the densely populated district to one-quarter of a square mile, notwithstanding other individuals of high standing in electrical circles held that areas of from one to four square miles could be worked to advantage."

Dr. Siemens went on to say:

"In considering the proper size of conductors, two principal factors have to be taken into account: First, the charge for interest and depreciation on the original cost of a unit length of the conductor, and secondly, the cost of the electrical energy lost through the resistance of a unit of length. The sum of these two, which may be regarded as the cost of the conveyance of electricity, is clearly least, as Sir William Thomson pointed out some time ago, when the two components are equal. This, then, is the principle on which the size of a conductor should be determined."

Lord Kelvin, commenting on Dr. Siemens' remarks of November 15, 1882, before a commission taking evidence with relation to the Edison feeder patent, said:

"There is not a word here of the necessity to secure against too great drop of electric potential between the dynamo and the lamps, or too great differences of drop between the different lamps of the system, and the narrow limitation of the area insisted upon shows that Dr. Siemens had no idea of Edison's solution of the problem, and thought only of overcoming the difficulty by enormously massive copper conductors with branches diverging from them to the points of consumption. From his earliest commencement as an inventor and engineer, Siemens had been occupied with water and gas. His first invention was a water meter, and it is not probable that anyone in the years 1879–80 knew better than he did of the difficulties met with in the distribution of water and gas and of the methods which had been practically used or proposed for overcoming them."

Again referring to this same subject, Sir William Thomson said:

"About that time, or a little later, one of our first electrical engineers, Mr. Crompton, who has, in fact, been the first to introduce successfully, and on a large scale, lighting from a central station in London, told me that he was obliged to use larger copper conductors than would be required merely in accordance with my principle for economy, in order to avoid so great a drop in potential as would be inconsistent with the good working of the lamps. At that time he had no idea of the feeder system, which he has since adopted with marked success in the Kensington-Knightsbridge electric lighting. Siemens' solution was not augmenting the size of the conductors above that calculated from the economic law, but to limit the size of the station supplied. Neither this nor the solution first proposed by Crompton is satisfactory in respect to the practical demands for the electric lighting of towns. Edison's feeder system is now universally admitted to be satisfactory to a very remarkable degree. I am asked why did not some one else invent it. The only answer to this, the last part of the question that I can think of, is that no one else was Edison."

I personally well remember Sir William Thomson's visit to the Pearl Street station in New York, in 1884, when he saw the Edison feeder system first in operation, and the great interest that he exhibited in studying it, and his admiration for the work accomplished by Mr. Edison in this connection.

I have thought it necessary to thus quote at length some of the leading English authorities on electrical matters, as I thought it would be better in claiming for an American the conception of the true basis of electrical distribution for light and power purposes, to give you the opinion and views on the matter of distribution of our "kith beyond the sea" rather than to quote the views of American scientists, who might possibly be considered more partial to the work of their own countryman.

It is often said that the principles of constant potential multiple arc distribution and the use of feeders to maintain an equal and economical distribution of pressure are self-evident propositions, following the lines of gas and water distribution; but when you have such high authorities as Conrad Cooke in 1879 failing to recognize any of these necessities, of Mr. Swan in 1880 only recognizing the principles of multiple arc, and in 1882 failing to recognize the importance and far reaching results of the feeder system, and Dr. Siemens as late as November, 1882, two months after a central station was in operation in New York City, adopting almost the same views as Mr. Swan, you cannot wonder at Lord Kelvin answering the question as to why someone else did not invent the feeder system by saying, "The only answer to this, that I can think of, is that no one else was Edison."

It would seem to me, with such authorities, that it is not unreasonable to claim that the development of the central station and distribution system connected therewith dates from Mr. Edison's work at Menlo Park. Mr. Edison had been engaged during the early seventies, first as a telegraph operator in the Western Union service, and later working on the gold indicators in the gold room in New Street, New York, during the stirring period of speculation in the precious metal which culminated on Black Friday in 1873. Prof. C. C. Law, now connected with the University of Missouri, had, I believe, charge of the indicating instruments, and it is a matter of some interest to record the fact that the first work Mr. Edison did of an inventive character which yielded him a financial return was in connection with and while he was at work on the gold indicators in question. Subsequently he was employed in the interest of what is now the Western Union Telegraph Company in improving the now universally used stock ticker. This work was followed by brilliant and successful work in connection with the duplex and quadruplex and automatic systems of telegraphy, and the invention of the phonograph and that part of the telephone now generally used for transmitting purposes and known as the carbon transmitter. His attention to the possibilities of what is popularly called the subdivision of the electric light was probably the result of a visit he paid to Mr. William Wallace, at Ansonia, in the fall of 1878, where he saw some experiments on dynamo machines, and on his return to Menlo Park he started his experiments on a system of electric light and power, which culminated in the successful starting of the first central station, in the lower portion of New York City, in September, 1882.

The public interest aroused in his work and the controversy as to whether it was possible for him to achieve anything that would be of commercial value is evidenced by the constant reference to the matter in the public press in 1878, 1879 and 1880, resulting in a panic in gas securities in London in 1878 and in New York in 1879. Probably the work of no inventor was more generally discussed on both sides of the Atlantic by laymen and technical authorities alike than was that of Mr. Edison on his electric lighting and power system. All kinds of comparisons were made as to the difference between the cost of gas and the cost of electricity. It was claimed by many that Mr. Edison could not possibly be considered as having succeeded in his work unless he could produce an illuminant that would compete commercially with gas. They lost sight of the fact that the characters of the two illuminants were entirely different, and that there was no more reason for supposing that, if electricity were more expensive than gas, the cost would be a barrier to its use any more than there is reason for supposing that gas should be considered a commercial failure because the poorest classes find it cheaper to use tallow dips. The probable reason for scientists and electricians doubting the possibility of a successful electric lighting system being produced was that all previous experimenting on incandescent lamps had been, as I have already stated, aiming at producing a lamp of the lowest possible resistance, and consequently requiring the greatest possible amount of current, these lamps being run in series, whereas Mr. Edison, at a comparatively early stage of his work, realized that the first essential was a lamp of high resistance, and that the only way of approximating an even distribution of pressure was to run these lamps in multiple arc. Hence his application for a patent on a lamp with a high resistance filament, under date of November 4, 1879, and his application on multiple arc distribution in February, 1880. It was then but a short time before he realized that, although experimentally this might give him even pressure, the expense of the copper in his distribution system would be too great, owing to the necessity of increasing the size of his copper as he got farther and farther from the point of generation. The result was that, in August, 1880, he applied for his patent on a system of feeders to supply his system of mains at various points throughout the system, the effect being a compact system with current flowing in all directions from the central point of generation through feeders, by means of which even pressure could be maintained throughout a considerable area.

A still further step made by Mr. Edison was the realization that nothing very reliable in the way of a distribution system in large cities could be maintained unless the work was placed underground, and, as a result of his work of a little over two years, we find that, in the early winter of 1880, Edison had a central station system experimentally at work at Menlo Park, N. J., having an underground two-wire system, with the homes of himself and his staff electrically illumined by incandescent lamps, motors at work in his laboratory, and, in fact, all of the essential features of what is to-day now so common from the largest cities to the smallest villages throughout the whole civilized world.

It was but a short time after the starting of the first central station, in New York, that Mr. Edison found himself looking for some more economical methods of distribution; and I well remember his first experiments on the three-wire system, when, at his shop in Goerck Street, New York, he placed a third brush on the neutral point of the commutator of a small bipolar Edison dynamo and demonstrated the practicability of the three-wire system.

At the same that Edison was working on the three-wire system experimentally in New York, Dr. John Hopkinson was probably figuring out the same thing in England, and Werner von Siemens was engaged in similar work in Germany. The records of the United States, English and German patent offices bear witness to the fact that these three men accomplished about the same results at about the same time, and, as a consequence, between 60 and 70 per cent. of the investment in copper was saved.

It is not my wish to address you on the scientific or technical side of central station development. I have thought it necessary to go at length into the early work of the art more for the purpose of giving you some idea of the position to which Mr. Edison is entitled as the father of central station work. My limited knowledge of the technique of the business would not permit me, even if I wished, to discuss the details of his early work, or of the early work of other experimenters; but I assure you that daily familiarity with the operation of one of the largest central stations in this country gives me a higher and higher appreciation of the simplicity and thoroughness and adaptability to all purposes of electrical distribution of the great work accomplished by the "Wizard of Menlo Park."

As a result of the experiments at Menlo Park, Mr. Edison, early in the winter of 1880, started to get together the necessary data for the establishment of a central station and distributing system in New York, in the district bounded by Wall Street on the south, Nassau Street on the west, Peck Slip on the north and South Street on the east, a territory covering about 2,000 feet square. He had each house thoroughly canvassed to show the number of lights in use, the number of hoistways and elevators and the horse power of the engines running machinery. You will find on the walls around us the blue prints of these original canvasses.* On one blue print you will find an enumeration of the power in use in that district and on the other blue print a record of the lights there used. As a result of this canvass, the Edison Electric Illuminating Company, of New York, was formed and drawings prepared for a central station, which was erected at 255 and 257 Pearl Street, the capacity of the station being 2,000 horse power, and the district fed by a system of half round copper mains and feeders, the mains being inclosed in lengths of iron pipe and insulated by a bituminous compound, each length of main being between 20 and 21 feet, so that it was possible to take off a service at each house.

Time will not permit me to go into the details of construction of this, the first central distribution system. You will see, by referring to the outline drawings of the station which I have with me, that the boilers were placed down below and were of the horizontal water-tube type, made by Babcock & Wilcox, carrying a pressure of 125 pounds, the steam machinery and dynamos being of the direct connected type and placed on a steel structure not dissimilar to that of some portions of the elevated railroad structure in New York.

Great care was taken in figuring out the system of mains and feeders, an immense plot of the district being represented by a series of resistances showing in miniature the probable consumption of current in the various parts of the district. It should be remembered that the path to be followed was practically unknown, that electrical distribution on a large scale was as much of a hidden secret as an unexplored continent, and the remarkable thing is that this first experimental system was a practical success, and a return on the money invested was being earned before electricians at home and abroad would recognize the success of the undertaking. It is but natural that many devices were used which were subsequently absolutely discarded. For instance, an elaborate system of resistances placed in series with the feeders was employed for maintaining an even pressure, entailing a considerable waste of energy. The lamp employed was not more than one-half as efficient as that used to-day, while the cost of manufacture was many times greater, and it had not one-quarter of the life of the present commercial incandescent lamp.

It might be well to pause for a moment and picture the condition of the art at that time. I refer to the winter of 1880. The plans for the central station were completed, the details of construction of the conductors in the street were all on paper, the dynamos and electrical instruments had no existence except on the draughting board, practically nothing was known of modern methods of insulation or house wiring, the socket and switch in use to-day had not been thought of, the miscellaneous devices now considered necessary in connection with house wiring had not been consider-

*The charts, curves and drawings referred to in the lecture are part of the confidential records of the Chicago Edison Company and the Edison Electric Illuminating Company, of New York. It is therefore impossible to publish them.

ed. In addition to the development of the system and its installation, manufacturing establishments had to be created in which to manufacture the first material needed, and Mr. Edison and his corps of assistants had to abandon the experiments of the laboratory and the designing of the draughting room to equip and manage shops in which to manufacture the apparatus necessary, from the generator to the lamp. Others have followed the beaten track, others have improved upon the methods employed, but the conception of the system, the perfecting of the original apparatus, its manufacture, its installation and its early operation, were all borne by an enthusiastic but small band of workers having an almost idolatrous belief in their chief as the pioneer of this great industry.

I have brought with me to-night a photograph of the original direct-connected steam generator known as the "Jumbo" machine, used in the Pearl Street station, composed of an engine manufactured by Armington & Sims, of Providence, R. I., of the single cylinder type, running at a speed of 350 revolutions, with what is practically the old form of Edison bipolar machine changed from a vertical to a horizontal position, the armature, instead of being wound with coils of wire, being built up of copper disks and bars. If you will glance from this to the picture of a modern central station unit composed of a compound, triple or quadruple expansion engine, with a multipolar dynamo connected directly on the engine shaft, you will find that the same broad engineering idea is alike apparent in the earliest and latest central station unit. The improvements in dynamo manufacture have enabled us to use lower speed engines, but the broad principle of direct connection is alike the same in both. That we should come back to exactly what Mr. Edison used in the earliest central station work is no mean tribute to him as an engineering authority.

The delay which necessarily occurs in carrying every new enterprise to a financial success acted as a wet blanket on central station development. Efforts were made to cheapen construction when it was found that capitalists in large cities were unprepared to risk their money in the enterprise. The apparatus was adapted to the requirements of smaller communities, and, as a result, a number of small stations were established throughout the country, especially in Pennsylvania, Ohio and Massachusetts. The development of the central station business for several years was confined to this class of work. The service was far from reliable, owing mainly to the necessity of doing the cheapest possible engineering and construction in order to meet the necessities of the slim exchequers of those who were bold enough to embark their capital in this business; but the Pearl Street station, started on September 5, 1882, with 5,500 lamps, rapidly developed, and in the fourteenth month of continuous running had 508 customers, wired for 12,732 lamps. Comparatively little work was done in central station lighting in Europe. A small station was started in Dijon, France, in June, 1883, and in the same year an installation was made in Santiago, Chile; in Milan, Italy; on Holborn Viaduct, London, and in Manchester.

The success of the Pearl Street station resulted in the extension of the New York system and the building of two stations uptown in New York, one in Twenty-sixth Street and the other in Thirty-ninth Street. This was followed by a station in Boston and another in Brooklyn. In 1887 the building of the first station in Chicago was started, the average load, as shown by the composite ampere curves of that station, which I have with me, being not much over 500 amperes for the year 1888. These latter stations, the two in New York, the one in Boston and the one in Chicago, were equipped with high speed engines belted to Edison bipolar dynamos of the Siemens armature type, in some cases the engines and dynamos being on the same floor, in other cases the engines being belted to the dynamos on the floor above. Numerous other stations were started, so that by 1890 upward of sixty cities were equipped with the direct current low-tension system, all of which, and numerous others, are to-day so remunerative that their securities are considered among the most desirable local investments, especially in cities of the first and second rank.

(To be continued.)

CHILDREN AND POISONOUS FLOWERS AND PLANTS.

BUTTERCUPS and daisies are generally associated in one's mind with Wordsworth, children and Arcadian simplicity. It is difficult to conceive of anything hurtful or dangerous in connection with the pretty little yellow flower, but, unfortunately, it is not always the most modest and retiring plants or flowers that are the least harmful; for example, the deadly nightshade (Atropa belladonna). Not that the buttercup can vie with the deadly nightshade in poisonous qualities, and still, when consumed in sufficient quantities, it will cause death. A proof of this has lately been afforded in England in the case of a boy who, after eating some buttercups, died within a few hours with all the symptoms of irritant poisoning. The buttercup belongs to the Ranunculaceæ, and nearly all the members of this group possess poisonous qualities, chiefly of an irritant nature, though in a few narcotic principles are to be found. Every year some children lose their lives by eating poisonous seeds or flowers, and care should be taken to exclude from gardens or parks where children play plants or shrubs of a poisonous nature, as deadly nightshade, laburnum and yew. Fortunately, buttercups, though nice to look at, do not, as a rule, tempt children to eat them wholesale, otherwise the mortality from this cause would be much greater than it is at present.—Pediatrics.

An estimate on the cost of the proposed Yukon railway, recently submitted to the Canadian government, places the total, for 208 miles, at $3,957,000, or an approximate cost of $19,000 per mile. The calculation is based upon the following apportionment: Stikine River to Teslin Lake, 30 miles, $746,000; 125 miles, light, at $13,000 per mile, $1,625,000; 30 miles, heavy, at $36,000 per mile, $1,080,000; 23 miles, medium, at $22,000 per mile, $506,000. The report states that if all preliminary arrangements are made and the final location decided before May 1, it will be possible to construct the entire line and put it in operation by September, 1898.

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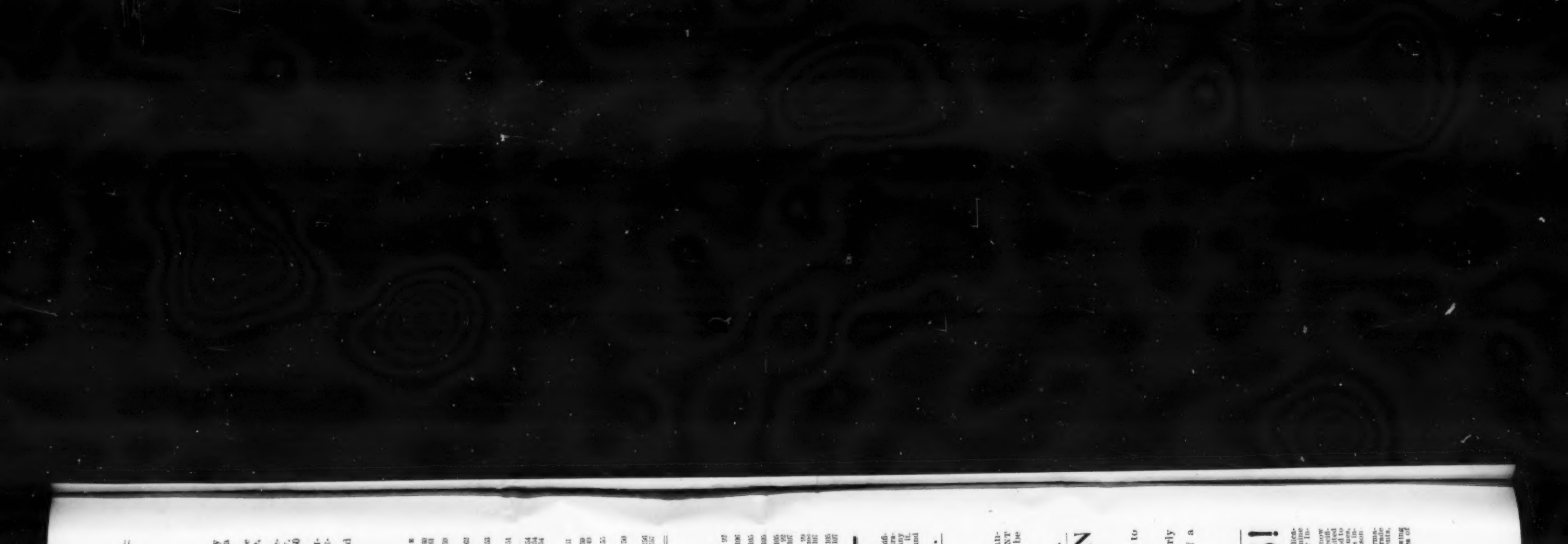
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